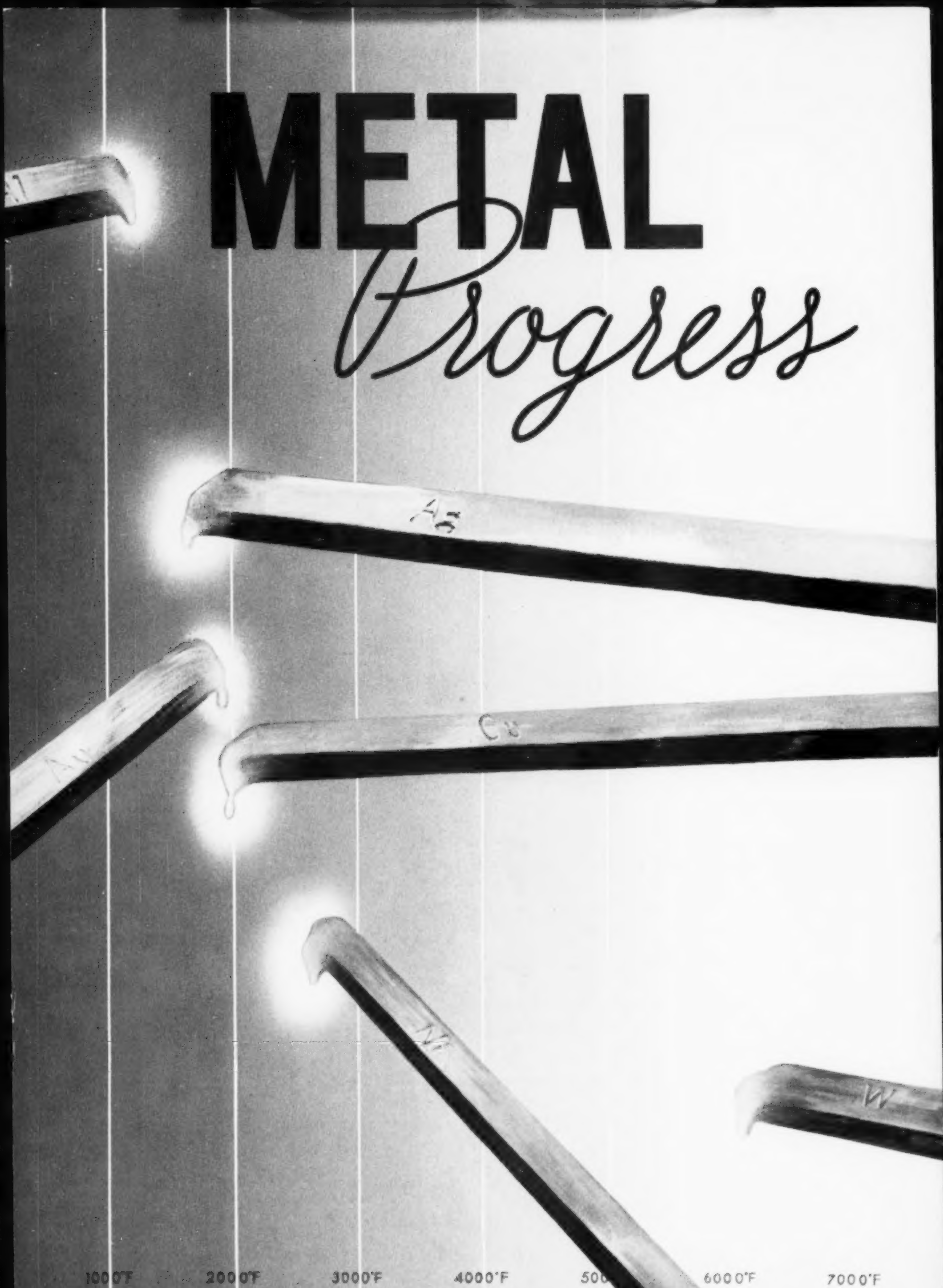
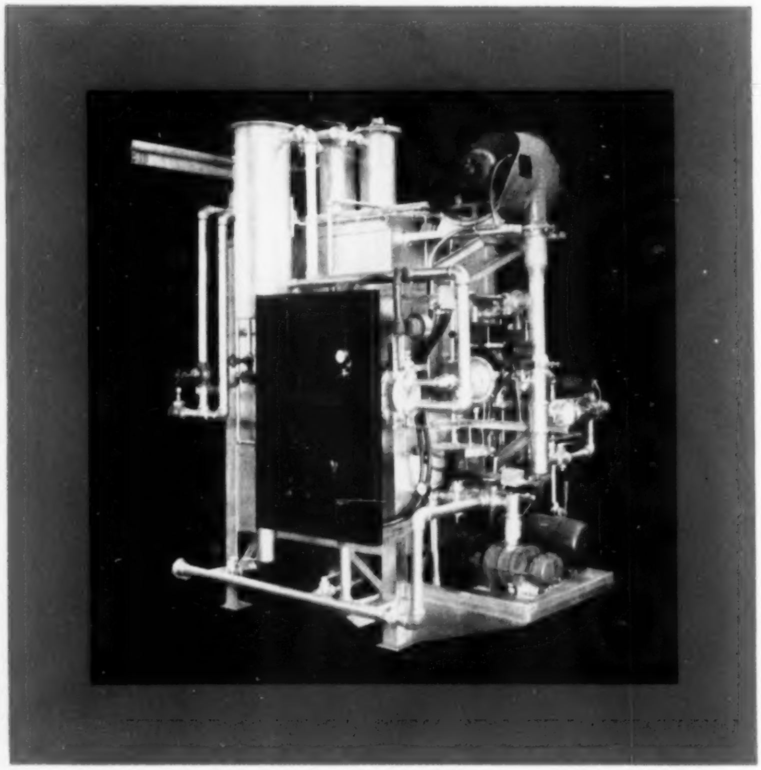
METAL Progress



KNOW WHAT YOU GET

RX DX NX HNX AX HX



There's a fourth dimension in every atmosphere generator, which makes a significant difference in Heat Treat productivity and equipment earning power. It's the number of *previous successful applications* which, in the case of Surface generators, runs literally into thousands. Indeed, they go back to 1929, the year of the first use of a neutral atmosphere for controlling oxidation of non-ferrous metal. If you want the best guarantee that specifications will be met or exceeded, specify 'Surface.' The latest and most authoritative data on gas atmospheres are presented in our bulletin SC-155. We'll be glad to send you a copy.

Specify SURFACE COMBUSTION ATMOSPHERE GENERATORS

POCKET-GUIDE

TO GAS ATMOSPHERES

FOR ALL REQUIREMENTS

GAS	CAPAC. c.f./hr.	APPLICATIONS
RX	250 to 5600	carburizing, dry cyaniding, brazing, sintering, bright annealing, clean hardening, carbon restoration (skin recovery)
DX LEAN	250 to 35,000	bright annealing and sintering (copper)
DX RICH	250 to 35,000	bright annealing, brazing (low and medium carbon steel)
NX	2500 to 20,000	bright annealing (copper, carbon steel), clean hardening (medium carbon steel)
HNX	5000 to 20,000	extra bright annealing (copper, low carbon steel), clean annealing (stainless steel)
AX	100 to 4000	rapid de-oxidation of surface metal, brazing, sintering (low carbon steel), bright annealing (stainless)
HX	1000 to 15,000	rapid de-oxidation of surface metal (low carbon steel), bright annealing (stainless)

This condensed table of Surface Combustion prepared atmospheres (designations are trademarked) shows at a glance how broad a range of heat treat requirements they meet. Specified gas compositions are accurately and economically maintained, over the entire range of capacities. Your nearby Surface representative can draw from an unequalled fund of industry-wide experience, and recommend equipment best suited to your job. Bulletin SC-155 presents 8 solid pages of valuable data.

Surface
HEAT TREATING EQUIPMENT

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

ALSO MAKERS OF

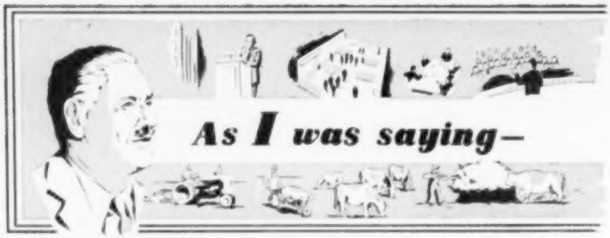
Kathabar HUMIDITY CONDITIONING *Janitrol* AUTOMATIC SPACE HEATING

IN THIS ISSUE

July seemed an appropriate month to run the glowing yellow-orange spectrum of heated metal on the cover. Artist is Lawrence Hohman, student at Cleveland School of Art.

***• See** Bill's Column*

on the other side



It was a great honor and pleasure to meet with the secretaries and the official representatives of the British and European technical associations and institutes.

After a luncheon attended by many officials of the Institute, the following remained for a conference: K. Headlam-Morley, secretary, Iron and Steel Institute; S. C. Guillan, secretary, Institute of Metals; K. P. Harten, director, Verein Deutscher Eisenhüttenleute; H. Schenck, president, Verein Deutscher Eisenhüttenleute; E. Wijkander, president, Jernkontoret; Howard Biers, representative, A.I.M.E.; George Rose, secretary, A.I.S.I.; W. H. Eisenman, A.S.M.

Mr. Headlam-Morley presided, stating that the British associations, in cooperation with technical groups from the continent, wished to invite the American societies to hold a joint metallurgical congress sometime between June 5 and 30, 1955. The meeting would be on a high technical level, he said, and because of limited facilities in England and the continent, overseas participants should not exceed 300 or 400.

It would be desirable for the Congress to last about three weeks, Mr. Headlam-Morley also indicated, assembling first in England for one week of technical sessions and plant visits. The group would then move to Germany (Dusseldorf) for another week spent in the same manner, and the final week would be spent in Paris. After the conference, opportunities would be provided for visits to other metallurgical countries if so desired.

Representatives from Sweden, Germany and France expressed their desire to join in the invitation and indicated their willingness to help make the meetings of the American societies in Europe successful.

The American representatives voiced appreciation of the invitation, and stated that their presence in London indicated the sincere and favorable interest of the American societies in the possibilities of the meeting.

A committee consisting of K. Headlam-Morley, chairman; E. Wijkander, Sweden; K. P. Harten, Germany; E. L. Dupuy, secretary, Société Francaise de Metallurgie, France, accepted responsibility for planning a meeting and will report within three months a complete outline of the divisions into which the technical program would be arranged, the plants to be visited, and the major activity of each, so that the American representatives could present the invitation in its proper light to their boards.

So here we are with the first stones in the foundation for an overseas meeting. This meeting is sure to be successful because one could see and feel the great warmth and enthusiasm behind the invitation. This was evidenced not only in this conference but in others that took place during the annual meeting of the British Institutes.

In the August issue I will give you a report on the fine reception and prominence given A.S.M. at the annual dinner of the British Iron & Steel Institute.

Cordially yours,

Bill

W. H. Eisenman, *Secretary*
American Society for Metals

Thermalloy retorts with bayonet-type plug end on the left. Firebricked ends of carbon steel retorts on the right were sealed over with clay paste before use.

THERMALLOY*

outlasts carbon steel retorts . . . 28 to 1

In a plant of a large eastern tool and specialty steel manufacturer, long, pipe-like retorts are used to anneal and heat-treat high-speed carbon and alloy steel bar stock in hood-type furnace equipment. Temperatures range up to 1650°F. during the annealing or heat-treating cycle that may last 30 hours.

Under these conditions, this manufacturer found that wrought carbon steel retorts scaled excessively and also distorted and flattened during operation . . . limiting service life to about 500 cycle hours. For the same operation, centrifugally cast Thermalloy retorts showed no measurable scale loss and maintained uniform wall thickness and shape. When last reported, Thermalloy retorts had been operating over 14,000 cycle hours and were still in perfect condition.

As the wrought carbon steel retorts became distorted, the plugs necessary to seal the open ends would not fit. Firebrick and a clay paste were used to seal the ends against infiltration of furnace gases. This made uniform annealing or heat-treating practically impossible. However, Thermalloy retorts, with plug ends designed by Electro-Alloys, afforded practically gas-tight seals and much greater ease of handling.

Today, this manufacturer is replacing all of the wrought carbon steel retorts with high heat-resistant Thermalloy retorts. Perhaps the same operating economy may interest you in Thermalloy retorts, furnace parts, trays, racks, pots or muffles. For full information, call in an Electro-Alloys engineer or write Electro-Alloys Division, 4002 Taylor Street, Elyria, Ohio.

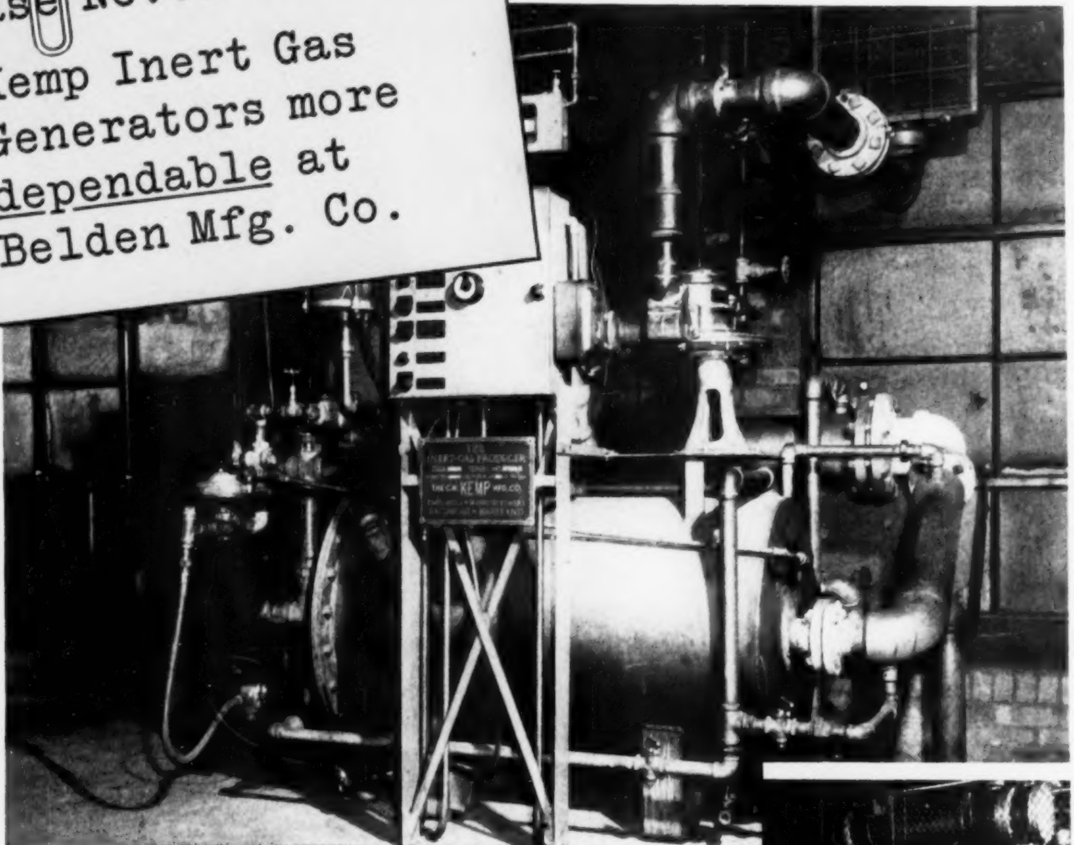
*Reg. U. S. Pat. Off.

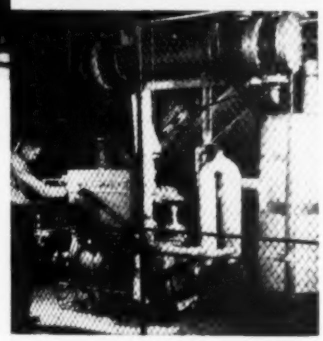
AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

Case No. 61

Kemp Inert Gas Generators more dependable at Belden Mfg. Co.





Generator on first floor of plant is enclosed in wire cage to prevent tampering with controls.

How Belden utilizes two Kemp Generators in annealing copper wire

Annealing copper wire necessitates cooling in an oxygen-free atmosphere to prevent harmful oxidation. For the required protective atmosphere in this process, the Belden Mfg. Co., Chicago, Ill., generates its own inert gas. But the generating equipment formerly used by Belden did not operate reliably . . . results were erratic. So Belden installed two Model MIHE Kemp Inert Gas Generators to handle this important job.

And Kemp *Handles* the Job

These two Kemp units assure Belden of a *dependable* inert supply. They deliver a more constant flow at the rated pressure . . . have been operating smoothly and satisfactorily since installation. Kemp's ability to produce a chemically clean inert at a *specific analysis regardless of demand* eliminates the danger of fluctuation at a critical stage.

Kemp Units Engineered for Service

Like Belden, you specify reliability when you specify Kemp. Every Kemp design includes the Kemp Industrial Carburetor for complete combustion without tinkering, without waste . . . for simplified installation and maintenance. Every Kemp design includes the very latest fire checks and safety devices. Annealing, hardening, sintering—whatever your problem, find out today how Kemp engineers can help you.

For more complete facts and technical information, write for Bulletin I-10 to: **THE C. M. KEMP MFG. CO., 405 East Oliver Street, Baltimore 2, Md.**

KEMP OF BALTIMORE

INERT GAS GENERATORS

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • ADSORPTIVE DRYERS
SINGEING EQUIPMENT

Experienced men and modern tools

machine Finkl forgings and die blocks to your specifications

In our modern machine shop the experienced eyes and hands of men like Herman, Carl, and Charley see that Finkl forgings and die blocks are machined to your requirements. We have complete control over the quality of the steel, forging and heat treating. These experienced men with modern machine tools complete the cycle thereby giving you the finest forgings and die blocks available.

Since 1879 "Forgings by Finkl" and die blocks for "Impressions that Last" have been quality products at lowest cost to you. When planning die block and forging requirements we invite you to call on our experienced men and modern facilities.

MANUFACTURERS OF THE LARGEST FORGINGS IN THE MIDDLE WEST

A. Finkl & Sons Co.

2011 SOUTHPORT AVENUE · CHICAGO 14

ELECTRIC FURNACE STEELS · DIE BLOCKS · FORGINGS

Metal Progress is published and copyrighted, 1953, by American Society for Metals, 7301 Euclid Avenue, Cleveland, Ohio. Issued monthly; subscriptions $7.50 a year. Entered as second-class matter Feb. 7, 1921, at the post office at Cleveland, Ohio, under the act of March 3, 1879.

DREVER

Vertical Furn

Save time and cost in Continuous Strip Annealing

TIN PLATE
BLUE PLATE
GALVANIZING
SILICON STRIP
BRASS AND COPPER ALLOYS
NICKEL SILVER
NICKEL AND NICKEL ALLOYS
BERYLLIUM COPPER

Today no major steel mill can overlook the advantages of Drever's pioneer vertical furnace design for Continuous Strip Annealing. Definite performance records prove the product uniformity and cost-reducing factor of the Drever method in annealing and processing Tin Plate Strip, Blue Plate and other strip products. Drever equipment is designed for output up to 30 tons per hour of 30" widths low carbon steel.

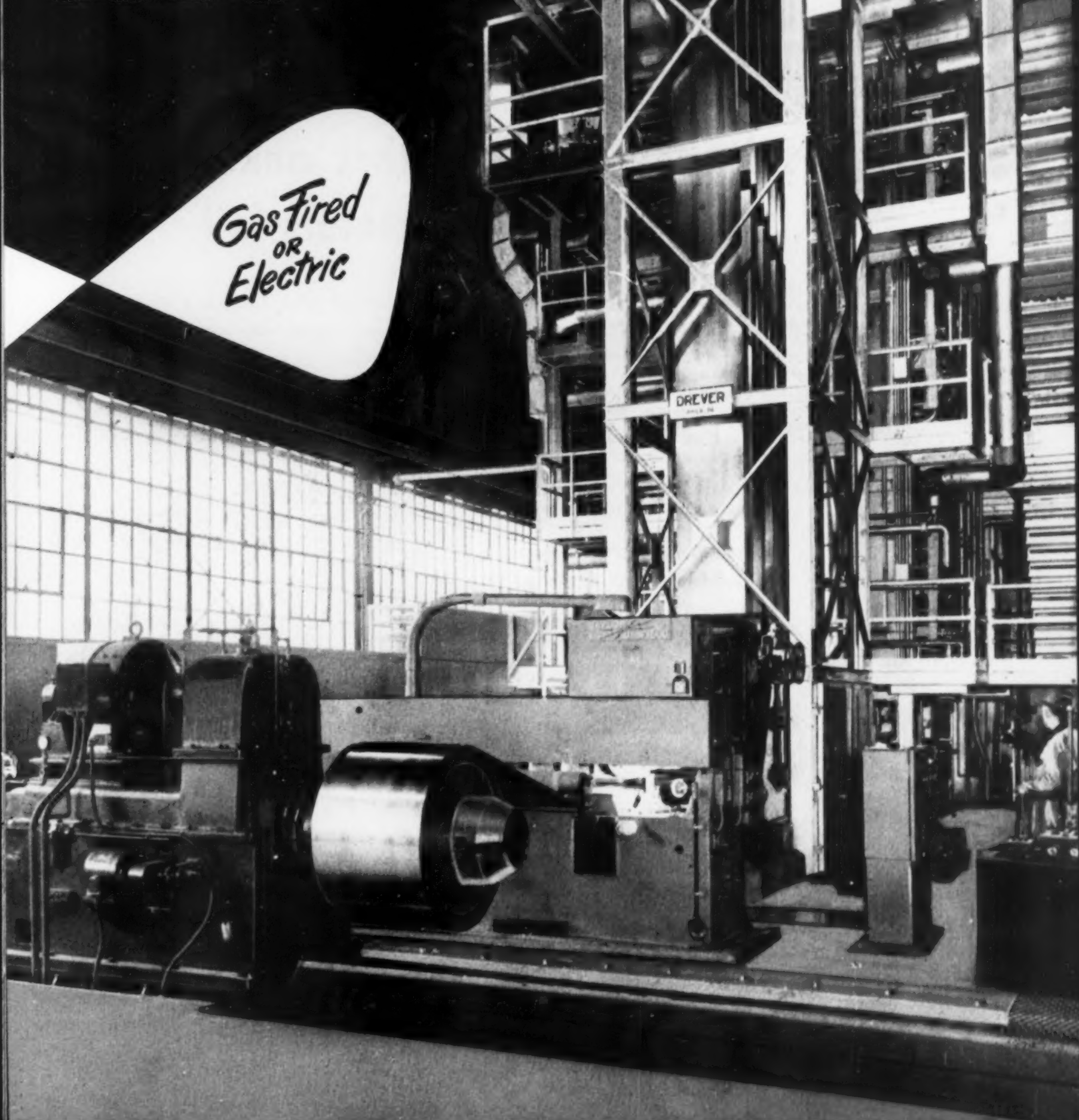
Let us prove the economy of Drever Vertical Furnaces.

DREVER CO.
790 E. VENANGO STREET • PHILADELPHIA 34, PA.

Pioneer Features

1. Speeds up to 1,000 ft. per minute
2. Controlled strip tension, excellent tracking
3. Controlled heating and soaking time, regulated cooling rate
4. Uniform annealing from edge to edge and end to end as well as throughout the coil
5. Less floor space, reduced coil inventory

aces



AMPCO

®

Producers of . . . "The Metal Without an Equal"

AMPCO* METAL

. . . the special alloys that make good where other metals fail

HERE are some of the properties of Ampco Metal that help you keep production up, costs down:

- **Unusual resistance to wear from abrasion, erosion, and cavitation pitting.**
- **Excellent resistance to corrosion in certain media.**
- **High tensile and compressive strength.**
- **High physicals at extreme temperatures.**
- **High strength-to-weight ratios.**
- **High impact and fatigue values.**

Because it combines all of these qualities, Ampco Metal is often called The Metal Without an Equal.

No matter what you do — whether you run a steel mill, refine oil, make stampings, generate power, work in the chemical or process industries, or any of hundreds of other jobs, you can make Ampco Metal work for you. It saves operating headaches and production grief, because it often makes good where other metals fail.

These versatile special alloys fight wear, corrosion, impact, fatigue; give long life and dependable performance under the severest conditions. That's why they are widely used in such tough assignments as slippers and screw-down nuts for blooming mill service, fractionating towers, aircraft parts, dies, valves, bushings, and other punishing jobs.

Chances are Ampco Metal can help you, too. It's available in sand and centrifugal castings, sheets, plates, bars, tubes, extrusions, welding wire and electrodes. Consult your nearby Ampco field engineer or write us for full information.

*Reg. U. S. Pat. Off.

AMPCO

AMPCO METAL, INC.

Dept. MP7 • Milwaukee 46, Wisconsin
West Coast Plant, Burbank, California

Ampco Metal, Inc.
Dept. MP7 • Milwaukee 46, Wisconsin
I am interested in learning more about the properties and uses of Ampco Metal. Please send me Bulletin 33.

Name .... Title ....
Company ....
Company Address ....
City .... ( ) State ....
D-14

telling the story of 'dag' dispersions

Lubrication Problem?

Check Properties of this Lubricant...

'dag' Colloidal Graphite—Dry solid, softer than talc, conducts heat. Forms tenacious *dry lubricating film* not affected by any temperature you are likely to meet. Dispersible in many fluids, co-dispersible with many solids. Impervious to degreasing agents, anti-corrosive. Kinetic coefficient of friction in the range of .065-.09 (mild steel or graphited steel).

In Wire Drawing—'dag' Colloidal Graphite lessens die wear, assures uniform wire dimensions. **In Forging**—By pre-treating dies with 'Aquadag', a dispersion of colloidal graphite in water, scaling and sticking are minimized, die life is lengthened. **In Stretch-Forming** — Colloidal graphite reduces tearing and rippling, eliminates seizing on the die. **In Piercing**—Piercers, punches, and similar tools are provided with a non-galling, self-lubricating film; extends die life. **In Other Applications**—In extruding, spinning, die-casting, ingot-mold stripping, press-fitting, cutting, and other metal-forming operations—wherever a high temperature lubricant or release agent is required —'dag' dispersions fill the bill. Write *today* for more detailed information. Ask for Bulletin No. 426-10G.

Dispersions of molybdenum disulfide are available in various carriers. We are also equipped to do custom dispersing of solids in a wide variety of vehicles.

Acheson Colloids Company

Port Huron, Michigan

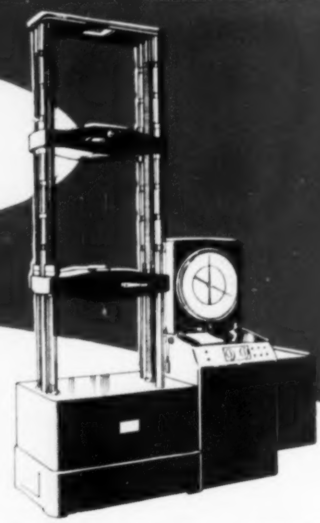
...also ACHESON COLLOIDS LIMITED, LONDON, ENGLAND

Units of Acheson Industries, Inc.

try 'dag' resin-bonded dry films for permanent lubrication

dag
DISPERSIONS

FROM ORANGE CRATES TO ARMOR PLATES



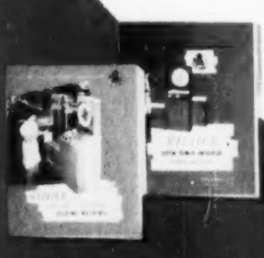
you can test practically anything with a RIEHLE

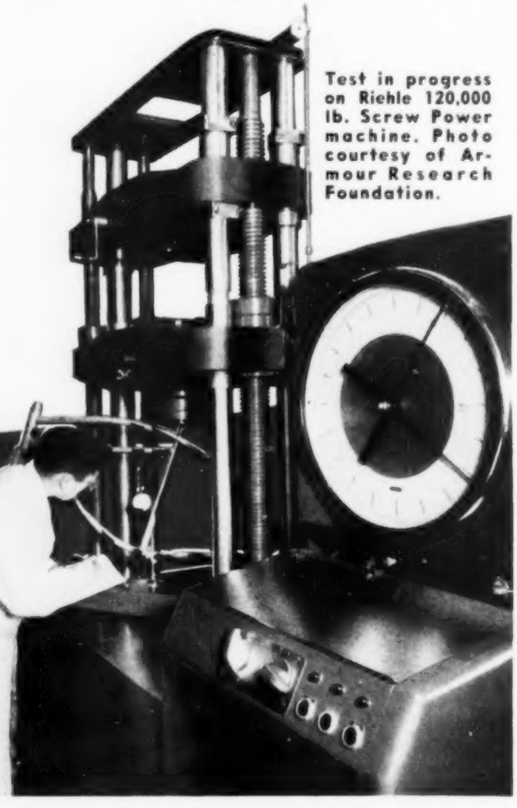
UNIVERSAL TESTING MACHINE

Owning a Riehle Pendomatic is like having five testing machines in one. Why? Because every Riehle Universal Testing Machine has 5 scale ranges to permit closer and more accurate reading. You can test specimens with relatively low rupture points and specimens with high yield points — all on the same machine. All you do is turn the selector knob to the logical range and run your test. Guaranteed accuracy is within 1/2 of 1%. Only a Riehle Pendomatic gives you 5 scale ranges.

WHAT ARE YOUR SPECIFIC NEEDS?

Riehle builds Universal Testing Machines with either hydraulic loading unit or screw power loading unit, in standard sizes up through 400,000 lbs. capacity and larger when required. Talk over your specific requirements with a Riehle specialist — you'll find him listed in the phone book under "testing equipment" — or write for illustrated catalogs.





Test in progress on Riehle 120,000 lb. Screw Power machine. Photo courtesy of Armour Research Foundation.

RIEHLE TESTING MACHINES

Division of AMERICAN MACHINE AND METALS, INC.
EAST MOLINE, ILLINOIS

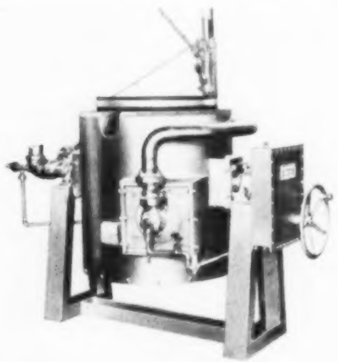
Chicago • Cleveland • Denver • Houston • Los Angeles
New York • Pittsburgh • Pittsfield, Mass. • Seattle

"ONE TEST IS WORTH A THOUSAND EXPERT OPINIONS"

engineering digest OF NEW PRODUCTS

Brass Melting Furnace

The Johnston Mfg. Co. has announced a new and improved brass melting furnace, either oil or gas fired. This furnace averages one hour for succeeding 900-lb. brass heats, gas fired. A new, enclosed tilting mechanism makes tilting easier than



before, and is designed so that an electrical drive may be applied. Silicon carbide linings are backed with insulating brick. Cover-lifting mechanism is operated from the front of the furnace.

For further information circle No. 1 on literature request card on p. 32-B.

300-Amp. A-C Welder

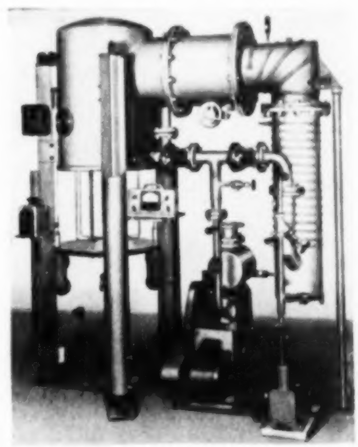
A redesigned 300-amp. a-c welding transformer, featuring stepless current selection from 40 to 375 amp., has been announced by the General Electric Co. The new welder, for

practically all applications from light-duty, low-current sheet metal work to heavier-duty, high-current industrial jobs, incorporates an enlarged scale and finely threaded screw adjustment to facilitate easy current selections. It accommodates electrodes from $\frac{3}{32}$ to $\frac{1}{4}$ in. diameter, and has a handy range switch which enables the operator to change quickly from high to low or low to high range.

For further information circle No. 2 on literature request card on p. 32-B.

Vacuum Coater

National Research Corp. has announced the Model 3111 coater for development work and limited commercial production in vacuum metallizing. Although the vacuum evapo-



ration of metals to provide metallic finishes has been established as a commercial process over the past ten years, process equipment has generally been limited either to laboratory apparatus or to large production units. Model 3111 bridges this gap.

For further information circle No. 3 on literature request card on p. 32-B.

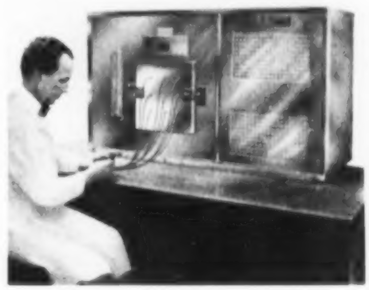
Iron Powder

A new patented process for the production of powdered iron has been perfected by Republic Steel Corp. Republic will utilize the process for the commercial production of iron powder in a new plant, the erection of which will start soon in Toledo, Ohio. The plant will have a capacity of 50,000 lb. per day. Republic also proposes to make iron powder for application in the field of flame scarfing and cutting where substantial quantities are used to intensify the heat of the flame.

For further information circle No. 4 on literature request card on p. 32-B.

For High and Low Temperatures

The Webber high-low temperature test chamber is capable of extreme temperature ranges, on the standard unit from −80° F. to +185° F., with temperature pull-down to −80° F. requiring 30 min. or less. Test cham-



ber dimensions are 12 by 12 by 12 in. The application of heat is accomplished through the use of reverse-cycle refrigeration, rather than with open heating elements. A blower is provided for even distribution of temperature and greater testing accuracy.

For further information circle No. 5 on literature request card on p. 32-B.

Hardenable Stainless

The availability of a new stainless alloy V2B has been announced by the Cooper Alloy Foundry Co. V2B is a hardenable 18-8 type of stainless steel having nominal composition: 19% Cr, 10% Ni, 3% Si, 2% Cu, 3% Mo, 0.6% Mn, and 0.15% Be, with less than 0.07% C. It is readily machinable in the quench-annealed state, and may be hardened by a low-temperature heat treatment which produces no distortion and only a light heat tinting discoloration, and which may be readily removed if necessary. In the annealed condition, the material is easily welded using special V2B welding rods. In addition to its use in a variety of corrosive applications, where its high hardness and non-galling features are required, V2B,

A guide for selecting temperature control for top furnace performance

Today, industry's need *for lower operating costs . . . reduced maintenance . . . high quality of production . . . has spot-lighted the importance of "tight" furnace control.*

With closer specifications and higher control standards, more and more plants must pin down troublesome, costly departures from favorable heat-treating conditions.

To meet this demand, Leeds and Northrup has a complete line of matched temperature control systems available. You get equipment matched to your particular requirements.

Each system comes to you as a "package" ready to handle the individual conditions created by your product, your production and your furnace.

TWO-POSITION CONTROL

For fuel-fired or electric furnaces

What it does:

Cuts heat input back to "low" when temperature exceeds control point . . . turns heat input on full when it falls below control point.

When to use it:

1. When changes in heat supply or changes in load are promptly "felt" by the temperature detector.

2. When alternate undershoot and overshoot will not damage product or process equipment, or slow down production.

3. When furnace pressure or fuel-air ratio *are not* controlled and the products of combustion *do not* form a protective atmosphere for the work.

PROPORTIONING-TYPE CONTROL

For fuel-fired furnaces

What it does:

Adjusts heat input by varying valve opening according to size of temperature change.

When to use it:

1. When there's a substantial time lag, before changes in heat supply or changes in load are "felt" by the temperature detector.

2. When load changes on continuous processes are both small and infrequent, and control point is rarely changed.

3. On batch process where operation is usually at the same temperature, and rapid recovery from upsets after loading is not important.

4. When furnace-pressure or fuel-air ratio *are* controlled, or the products of combustion *do* form a protective atmosphere for the work.

There's an L&N control

POSITION-ADJUSTING-TYPE CONTROL (P.A.T.)

For fuel-fired furnaces

What it does:

Adjusts heat input by varying valve opening according to size, duration and speed of temperature changes.

When to use it:

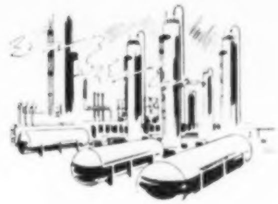
1. When there's a substantial time lag, before changes in heat supply or changes in load are "felt" by the temperature detector.

2. When load changes are both large and frequent and control point must be changed to suit various conditions.

3. When furnace design requires a continuously throttled flame.

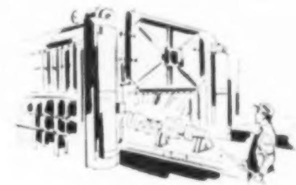
4. When furnace-pressure or fuel-air ratio *are* controlled, or the products of combustion *do* form a protective atmosphere for the work.

5. Whenever overshoot is costly, hazardous or can cause damage to the product or heating equipment.



Refining Towers

Tunnel Kilns



Forging Furnaces

Open Hearths

DURATION-ADJUSTING-TYPE CONTROL (D.A.T.)

For fuel-fired or electric furnaces

What it does:

Adjusts heat input by varying length of "heat on" time according to size, duration and speed of temperature changes.

When to use it:

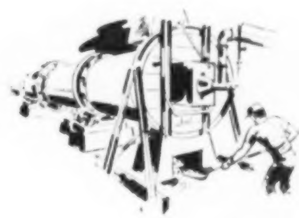
1. When there's a substantial time lag, before changes in heat supply or changes in load are "felt" by the temperature detector.

2. When load changes are both large and frequent, and control point must be changed to suit various conditions.

3. When furnace design requires use of "on-off" operation of heat supply.

4. When furnace-pressure or fuel-air ratio *are not* controlled, and the products of combustion *do not* form a protective atmosphere for the work.

5. Whenever overshoot is costly, hazardous or can cause damage to the product or heating equipment.



Rotary Kilns

Annealing furnaces

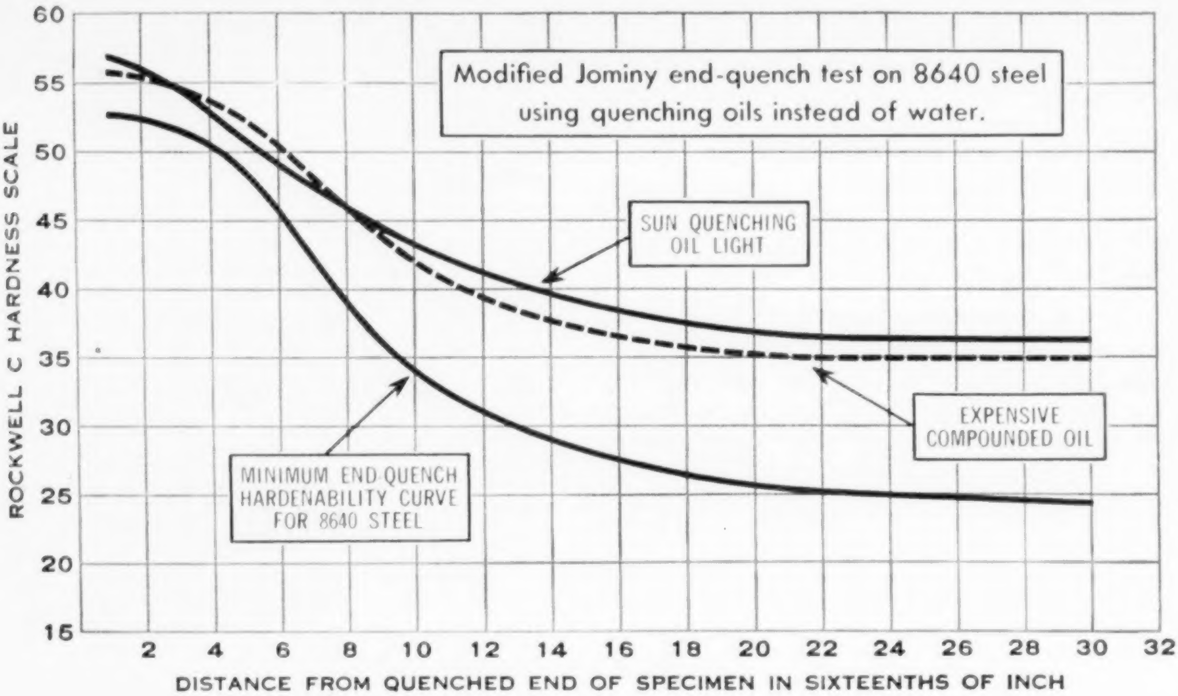
For complete information regarding L&N Matched Temperature Control, write 4927 Stenton Ave., Phila. 44, Pa., or contact our nearest office.

to match every industrial furnace

LEEDS & NORTHRUP

instruments · automatic controls · furnaces

Jrl ad N-33(53)



You can do 95% of all quenching jobs by using SUN QUENCHING OILS

This has been proved again and again in industrial heat treating departments and in the laboratory. The above test curves compare the results obtained from Sun Quenching Oil Light and those from an expensive compounded quenching oil. The hardnesses obtained are far above the commonly accepted minimum.

In addition to assuring consistently uniform physical characteristics, Sun Quenching Oils prevent sludge formation and help remove any deposits that may exist. Oil coolers are kept clean; maintenance costs are decreased. Sun Quenching Oils lower operating costs too. They thin out when heated, drain off parts faster and more completely. Make-up is materially reduced.

For more information about Sun Quenching Oils and how they can help you, call your nearest Sun office or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. MP-7.

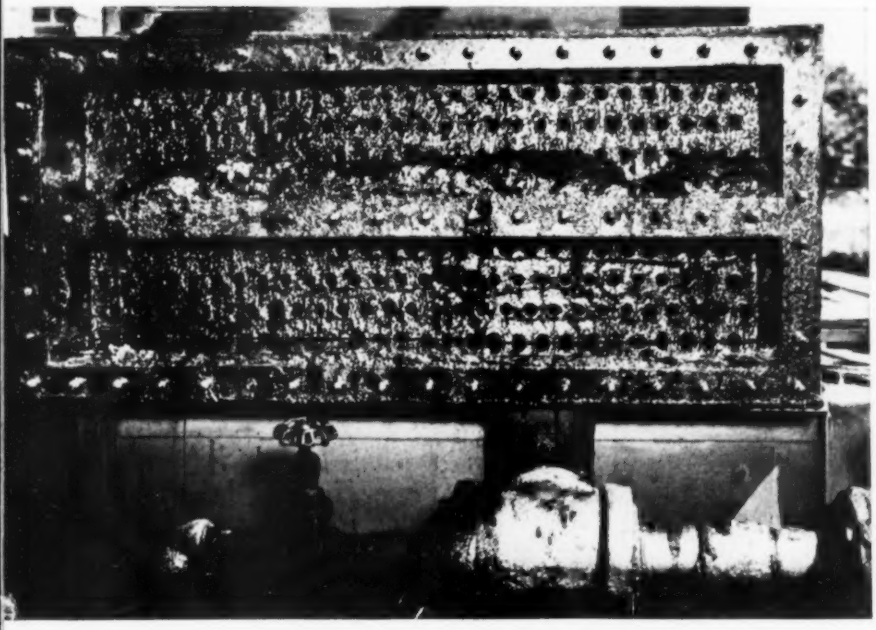
INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

SUNOCO

PHILADELPHIA 3, PA. ◆ SUN OIL COMPANY LTD., TORONTO & MONTREAL

THIS PLANT QUENCHES ALL TYPES and sizes of automotive and aircraft forgings. Sun Quenching Oil Light serves all five of the 2400-3000 gallon systems. In the seven years the shop has been using this oil, no unit has been down except for normal mill scale removal.



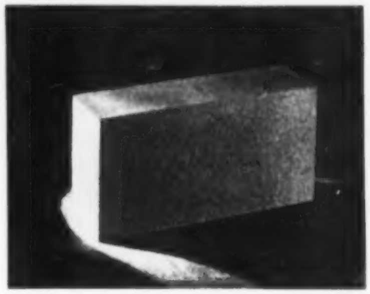
AN OIL THAT FORMS SLUDGE CLOGS oil coolers, increases maintenance and operating costs. Sun Quenching Oils have a natural detergency which helps keep the systems clean and removes any deposits that may exist.

INDUSTRIAL PRODUCTS DEPARTMENT
SUN OIL COMPANY SUNOCO
PHILADELPHIA 3, PA. ♦ SUN OIL COMPANY LTD., TORONTO & MONTREAL

unlike other precipitation hardenable alloys, does not over-age at elevated temperatures and may therefore be used safely in steam applications and at temperatures up to 1400° F. Comparative data on corrosion resistance are available.
For further information circle No. 6 on literature request card on p. 32-B.

Insulating Firebrick

An insulating firebrick, introduced by the Zonolite Co. and made of vermiculite and clay binders, is designed

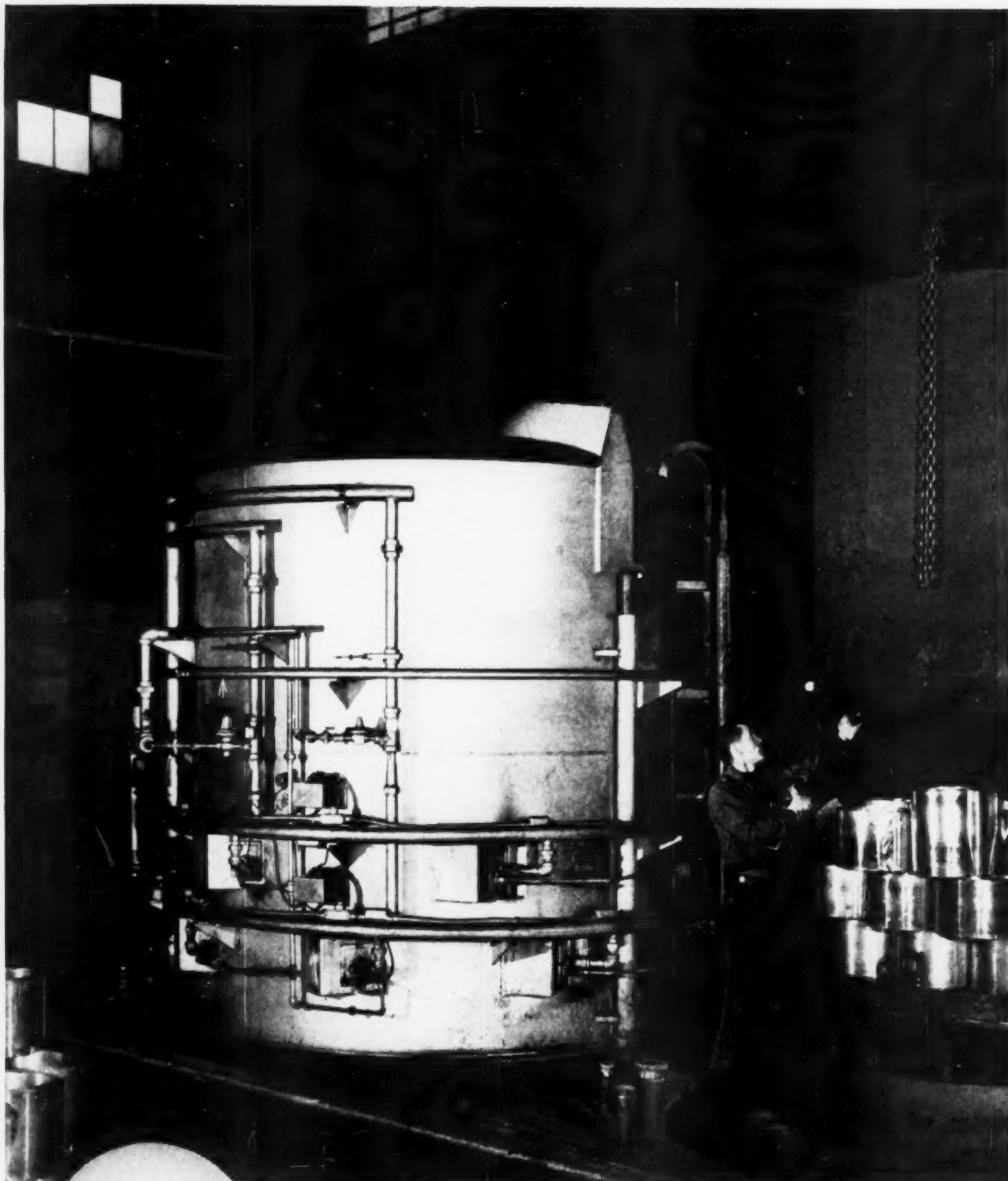


primarily as back-up insulation for refractory brick in the range up to 1800° F. When not subjected to mechanical abrasion or exposed to molten slag or metal, it can be used as facing brick at temperatures up to 1800°.
For further information circle No. 7 on literature request card on p. 32-B.

Radiation Detector

Self-contained and requiring neither batteries nor external charging devices, Consolidated Engineering Corp.'s Gamatek radiation detector is

a pocket-size instrument which accurately indicates on a direct-reading scale the total dosage of Gamma and X-rays to which an area has been subjected. By observing the time the needle takes to move across the scale and referring to a simple table printed on the back, the instrument can be used as a radiation rate-meter.



IF YOUR PRODUCT CALLS FOR HEAT-TREATING . . . IT CALLS FOR A WESTINGHOUSE FURNACE . . . *GAS OR ELECTRIC.*

"Capacity increased, production up, costs cut..."

says C. G. Hussey & Co.

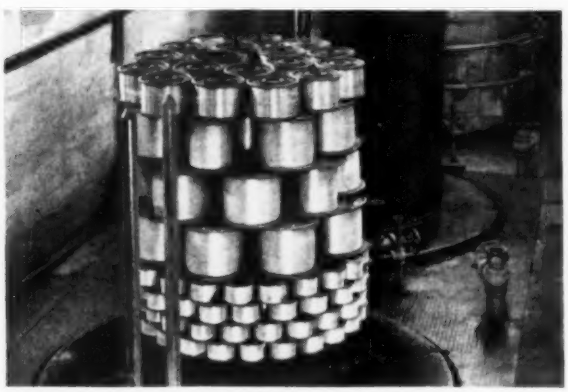
"Sixteen years of nonstop operation is the record of our two Westinghouse Recuperative Furnaces. Therefore, while looking for a furnace to expand our operations to include the annealing of copper sheets and coils, we naturally thought of Westinghouse. Since oxide would form on these coils and sheets when heat-treating in an open-type furnace, considerable time and man power was lost by removing this oxide with sulphuric acid baths. Solution came in the form of a Westinghouse Gas-Fired, Bell-Type Furnace. We have had our Bell-Type Furnace in operation for two and one half years and enjoy definite savings in cost ... production time, and an increase in output capacity."

Whether it be for your production line, toolroom, or laboratory, you'll get the heat-treating flexibility you need and want with Westinghouse Heat-Treating Furnaces . . . GAS OR ELECTRIC.

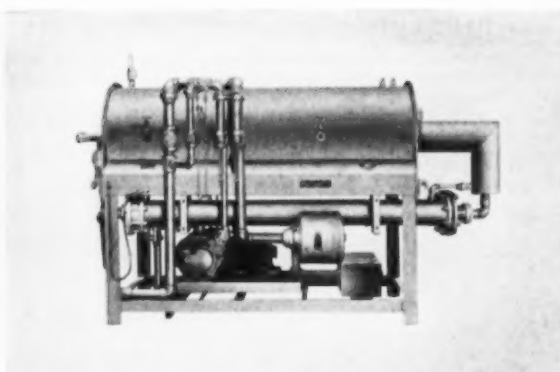
For more information regarding Westinghouse Heat-Treating Furnaces, write today for your copy of the 40-page booklet *Harnessing Heat* (B-5459) Westinghouse Electric Corporation, Industrial Heating Department, Meadville, Pennsylvania. J-10385

YOU CAN BE **SURE**...IF IT'S

Westinghouse



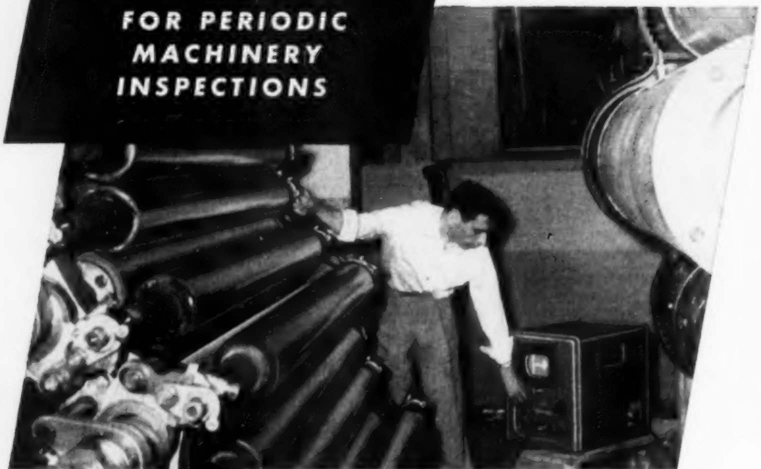
TYPICAL gas-fired installation, used for annealing copper wire—with Exogas®. Protective equipment shuts off power and gas in event of failure of air pressure, gas pressure or electricity. Shown on the firing base are coils of copper sheets prior to bright annealing.



8000 CFH EXOGAS GENERATOR with the Bell-Type Furnace. Among its many uses, Exogas® is used for clean normalizing of low-carbon steel, tempering and drawing of ferrous metals, bright annealing of copper, bright silver soldering of copper and brass.

Reduce SHUT-DOWN Costs

FOR PERIODIC MACHINERY INSPECTIONS



Inspecting inking rolls on a printing press . . . without disassembly.

with Sperry Ultrasonic

REFLECTOSCOPE TESTING

NOW AVAILABLE FOR ANY DESIRED TERM THROUGH ECONOMICAL SPERRY INSPECTION SERVICE

Sperry Ultrasonic Testing makes it possible to conduct your periodic inspections of machinery and other production equipment rapidly and dependably without time and money-wasting disassembly. Penetrating up to 30 feet in solid metal, this latest and finest of the non-destructive testing methods locates hidden defects not detectable by the most careful visual inspection.

In addition to speeding up inspection periods, Ultrasonic Testing prevents on-the-job equipment failure by finding sub-surface flaws; needed repairs can be scheduled for slack periods.

Reflectoscope Testing is available when you need it on an economical basis. Hire an experienced inspection engineer using a Sperry Reflectoscope for any desired time from 4 hours up.

WRITE NOW FOR COMPLETE INFORMATION

KEEP UP-TO-DATE on the latest testing data.

Use the coupon below to send for your copies of the newest Industrial Application Reports.

Ultrasonic Sperry Inspection

SPERRY PRODUCTS, INC.
507 SHELTER ROCK ROAD
DANBURY, CONNECTICUT

☐ Please put me on your mailing list for Industrial Application Reports.
☐ Have a SPERRY Representative drop in when he's in the area.

MATERIAL TO BE TESTED ______
NAME ______
TITLE ______
COMPANY ______
CO. ADDRESS ______
CITY ______ ZONE ______ STATE ______

It is designed for monitoring in atomic research, industrial radiology and radio-isotope applications. Full-scale reading is 250 milliroentgens, more than adequate for the total allowable daily dosage.

For further information circle No. 8 on literature request card on p. 32-B.

Titanium Tubing

The smallest size tubing ever drawn from commercially pure titanium has been announced by Superior Tube Co. Outside diameter is only 0.0455 in.;

wall thickness is 0.00225 in. At present, this unusually small size titanium tubing is used for experimental work in the electrical, electronic and chemical industries. All of the company's thin-wall titanium tubing is vacuum annealed to avoid embrittlement.

For further information circle No. 9 on literature request card on p. 32-B.

Pyrometer Controller

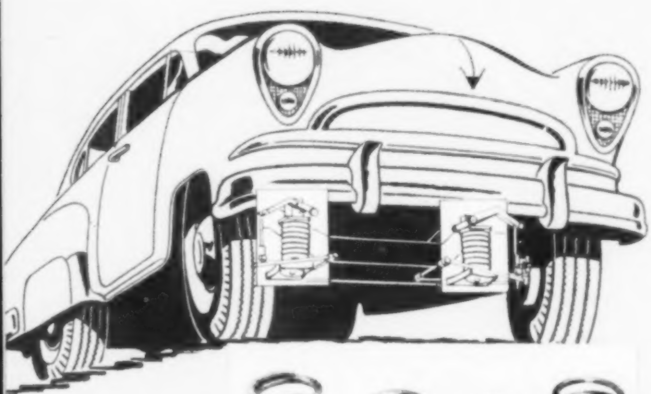
For automatically controlling the temperature of batch processes or equipment suitable for two-position control action, Thermo Electric Co.,

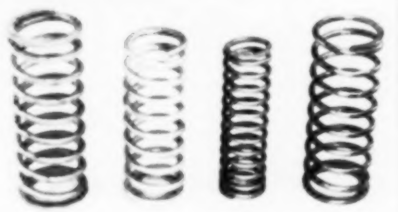
Inc., has introduced their newly designed electronic pyrometer controller for use with iron-constantan, chromel-alumel or platinum-platinum-rhodium

New facts for your file on U·S·S CARILLOY STEELS

HALF THE NEW CARS HAVE COIL SPRINGS MADE OF U·S·S CARILLOY PRECISION ROLLED COIL SPRING ROUNDS . . .

- **they are twice as accurate as ordinary hot-rolled bars**
- **require little or no centerless grinding**
- ***and they cost less to use***





● In the early days of the development of coil springs for front suspensions of automobiles, the only steel that was available was an ordinary hot-rolled bar from which as much as .035" of metal per side had to be removed by grinding to insure freedom from harmful seams, pits, and decarburization. This cost money, was wasteful and time consuming.

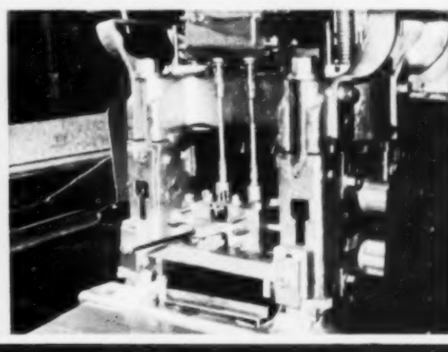
This seemed to be an expensive approach to a simple problem, so United States Steel equipped one of their mills to produce hot-rolled bars to eliminate harmful defects and most of the grinding expense. They devised a method for rolling a bar to half the standard tolerances, with half the amount or less of decarburization, which made it attractive to use the material "as furnished" or with a small amount of centerless grinding. We call this bar a Precision Rolled Coil Spring Round. It has performed excellently when used "as furnished" or with a small amount of grinding.

This exclusive development has paid off in two ways. It paid us because the CARILLOY Precision Rolled Coil Spring Round is now used in over half of the coil springs in new automobiles. But, most of all, it has paid off for the automobile manufacturer in that his costs are reduced with performance of the highest order. Today we are still hard at work developing new and better alloy steels for other new uses in automobiles; for example, in automatic transmissions, power steering units and other new and vital automobile parts.

Our experienced engineers and metallurgists will be glad to consult with *you* on any steel or fabrication problem. Just write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

Here, at Muehlhausen Spring Division of Standard Steel Spring Co., precision rolled U·S·S CARILLOY Coil Spring Rounds are coiled without centerless grinding. CARILLOY Rounds have a guaranteed minimum decarburization, and they cost less to use.

At the Gary Works of United States Steel, this precision mill rolls CARILLOY Coil Spring Rounds with extreme accuracy. Tolerances are only half of standard; .004" on the diameter, instead of the usual .008", and only .006" out of round, compared to .012" on ordinary rolled bars.



Coil springs made of CARILLOY Precision Spring Rounds have been proved in severe laboratory tests, as well as in actual service on America's best automobiles. They perform so well that half of all automobile coil springs are now made of CARILLOY steel.

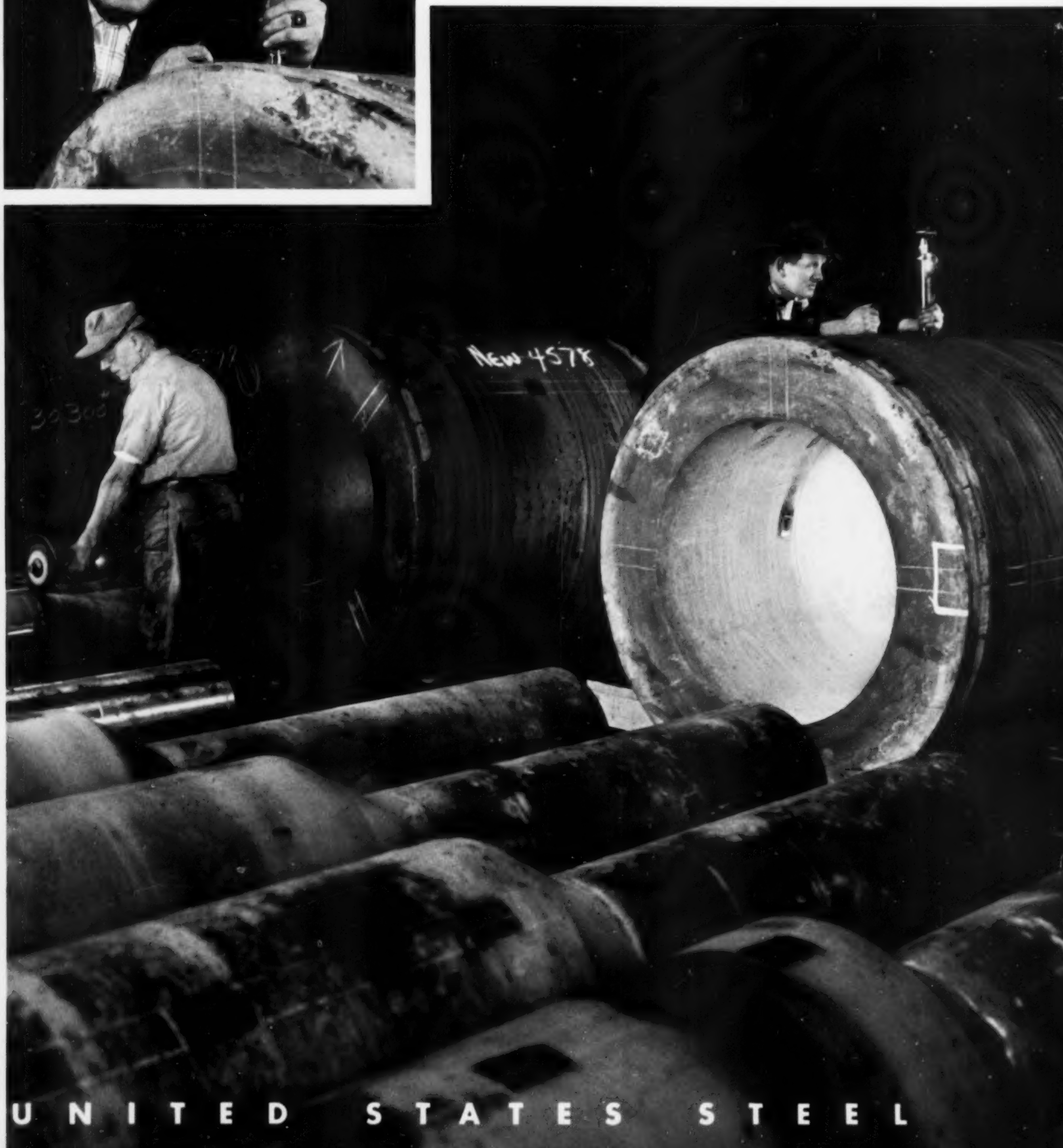
USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

"Our forgings

—says *John Dobos,*



are tested with diamonds"

U·S·Steel Inspector

THOUGH it's a fairly common instrument, visitors to our Homestead Forgings Division are always fascinated by the scleroscope.

It consists of a tup with a diamond point enclosed in a glass tube which falls from a predetermined height. The tup is dropped on the surface of a forging, and the height of the *rebound* is a measure of the hardness of the steel. John Dobos, a U. S. Steel Inspector for 13 years, is pictured using one to test the surface hardness of a back-up roll sleeve used in a continuous cold mill.

Useful as it is, the scleroscope is only a part of our test equipment. Forgings are also tested with modern magnetic particle, ultrasonic and boroscopic equipment. Our well-equipped laboratories determine tensile properties and examine microscopic and macroscopic samples for cleanliness, structure and soundness. We even have a furnace built over a lathe to check dimensional stability of certain forgings at their actual operating temperature.

The reason for all this? Customers' requirements become more stringent every year. So we are constantly buying new inspection equipment, setting up improved testing procedures and training our men to do an even better inspection job.

Most important, of course, are the men. When you buy U·S·S Quality Forgings, men like John Dobos do the work. They've got the long years of experience, the equipment and the firm determination to give you the finest forgings that money can buy.

For more information, or for our 32-page booklet on U·S·S Quality Forgings, write to United States Steel, Room 2813-E, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS *Quality* **FORGINGS**

- heavy machinery parts—carbon, alloy, stainless
- electrical and water wheel shafts
- hammer bases and columns
- marine forgings

New facts for your file on U·S·S CARILLOY STEELS

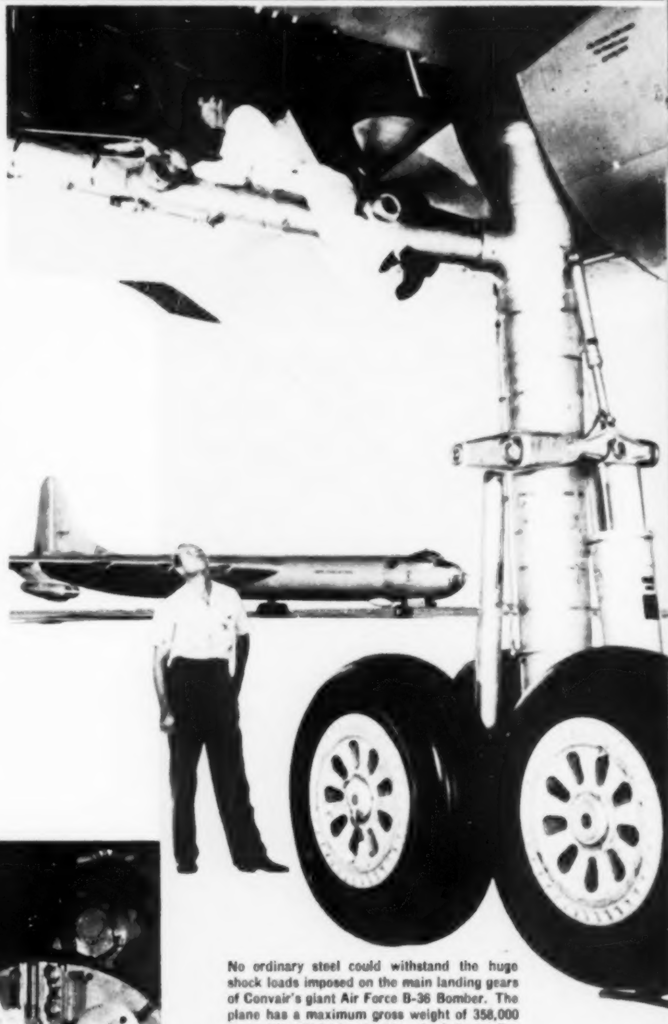
Every B-36 lands on U·S·S Carilloy steel

● When 179 tons of B-36 thump down on a landing strip, tremendous stresses are built up in the structural parts of the landing gear. Only the highest quality in steel can handle this tough job, which is one of the most exacting in the aircraft industry.

All of the rugged main columns for these landing gears are made from U·S·S CARILLOY electric-furnace aircraft quality ingots. This high quality alloy steel provides the great strength and shock resistance demanded in the performance of the finished part. The main columns for these landing gears are forged. The original ingot, as shipped to the forger, weighs approximately 37,500 lbs. From it are produced two columns, each weighing about 1200 lbs. In other words, approximately 93% of the steel has been removed—with a mere 7% of the original ingot left to do this tremendous job. Obviously, this steel must be of the very best quality.

The same care and skill go into every ton of CARILLOY steel that *you* buy, whether it's a giant alloy ingot or a few tons of special steel. Our experienced metallurgists keep a close check on *every* heat of steel to make sure it has the strength, hardness, toughness and machinability that's needed.

If you have a special steel problem, let us know. We'll be glad to help you with it.



No ordinary steel could withstand the huge shock loads imposed on the main landing gears of Convair's giant Air Force B-36 Bomber. The plane has a maximum gross weight of 358,000 lbs., with still higher landing shock loads. But U·S·S Carilloy steel has more than enough impact strength to hold up under this severe punishment.

U·S·S Carilloy electric-furnace aircraft quality steel meets every requirement for these vital parts. The precision machining and expert heat treatment they get at Cleveland Pneumatic Tool Company complete the job.

USS

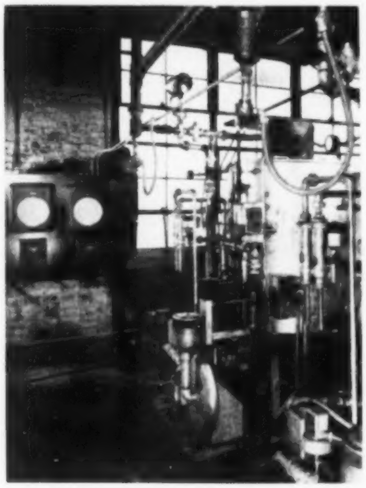
UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

thermocouples. Twelve standard scale ranges are available for controlling temperatures from 0 to 3000° F. This instrument combines the measuring accuracy of a null balance potentiometer circuit with the sensitivity and speed of an electronic control system.
For further information circle No. 10 on literature request card on p. 32-B.

Furnace Atmospheres

The Foxboro dew point recorder, which detects the moisture content of furnace atmospheres, monitors a con-



tinuous sample of gas, permitting the operator to make accurate generator adjustments and to hold the moisture content within desired operating limits. As installed in a number of metal treating plants, the instrumentation consists of a two-pen recorder, a Dewcel power unit and two sensitive elements (dry bulb and Dewcel). A minute flowing sample of gas from the furnace or the exhaust is piped to a sampling chamber where the Dewcel measuring element senses the dew point temperature to within ±2° F. A second pen records gas ambient temperatures. The humidity sensitive element provides a laboratory standard of measurement even in severe industrial service.
For further information circle No. 11 on literature request card on p. 32-B.

Abrasive Blasting Machine

R. W. Renton and Co. has announced a redesigned liquid abrasive blasting machine designed to clean, finish, deburr, blend or etch a wide variety of dies, molds, tools and other parts. The liquid slurry is drawn up by siphon injection and propelled from the blasting nozzle by a high-velocity air stream. The new machine is designed to handle abrasives rang-

WAUKEE FLO-METERS

. . for measuring industrial gases

for measuring
- **air**
- **ammonia**
- **dissociated ammonia**
- **butane**
- **city gas**
- **endothermic cracked**
- **exothermic cracked**
- **hydrogen**
- **natural gas**
- **nitrogen**
- **oxygen**
- **propane**

Here at last is the truly modern flo-meter that offers important and exclusive advantages for every user.

1. **Easy to clean.** No tools are needed for disassembly . . can be completely cleaned and reassembled in 2 minutes.
2. **Easy to read.** 6" scale gives extra visibility. Exclusive Waukee tabs identify in large red letters gas being measured. Eliminates mistakes.
3. **Built-in control valves.** Operators can easily see flow change.
4. **Easy to mount.** Can be panel mounted . . piping is simpler, installation costs less.

For additional information request bulletin #201.

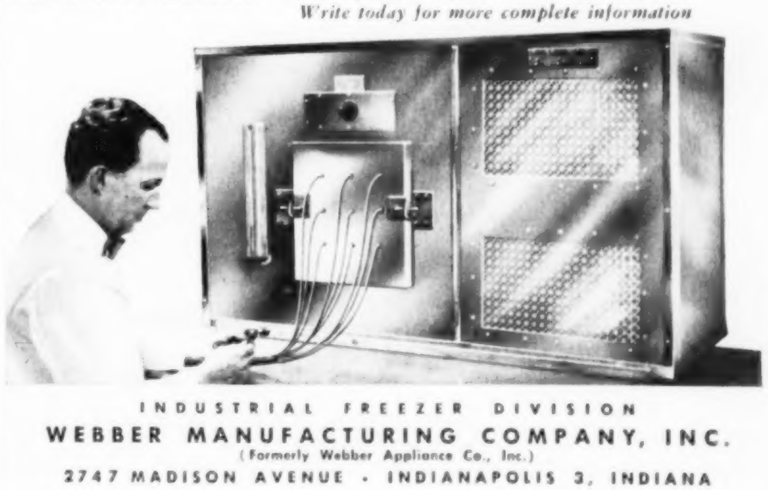
Waukee **ENGINEERING COMPANY**
759 Milwaukee Street, Milwaukee, Wis.

HIGH AND LOW TEMPERATURES

NEW BENCH-TYPE TEST UNIT

WEBBER
TRADE MARK REGISTERED
COMPLETE TEMPERATURE RANGE
TESTING UNITS

Combine high and low temperatures within the same cabinet with all controls self contained. Unit measures 50"x28"x20" with a testing chamber 12"x12"x12". Temperature range is from -80° F., to 185° F. Heat application is accomplished with reverse cycle refrigeration, which eliminates the hazards associated with open heating elements. A blower is provided for even distribution of temperatures and greater testing accuracy. Latch-type or hinge-type door optional. Accelerated pull-down to -80° in 30 minutes or less.
Write today for more complete information

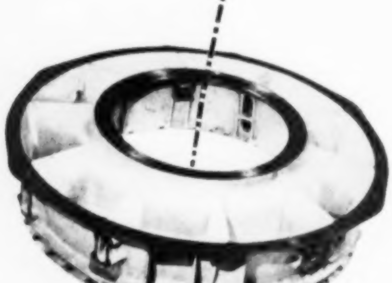


INDUSTRIAL FREEZER DIVISION
WEBBER MANUFACTURING COMPANY, INC.
(Formerly Webber Appliance Co., Inc.)
2747 MADISON AVENUE · INDIANAPOLIS 3, INDIANA

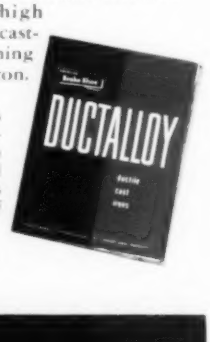
Ductalloy® castings make "impossible" parts producible

This highly stressed part secures the 7,200-lb. thrust Wright J-65 jet engine in the aircraft, carries major structural members ahead of and behind it, and mounts a main shaft bearing in its center. Air roars between the carefully contoured inner and outer rings.

As originally hogged out from an aluminum forging on an experimental basis, this part required some 1200 hours of machining—impractical for volume production. Redesigned by Curtiss-Wright Corporation's Wright Aeronautical Division as a weldment of two Ductalloy precision castings, it requires only simple turning and facing plus 25 ft. of welding to assemble the ten interconnecting stainless steel struts. An "impossible" part for volume manufacture in other metals which would meet specifications, it is rendered readily producible in Ductalloy—Brake Shoe's ductile cast iron that combines high strength with the casting and machining qualities of gray iron.



Wright J-65 jet engine main bearing support . . . impractical to machine from one piece. Readily produced as a weldment of two Ductalloy precision castings.



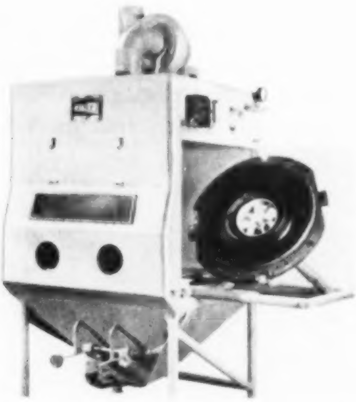
YOUR PROBLEM—Ductalloy may solve your problem if it involves economical production of complex metal shapes that are difficult to cast in steel, expensive to forge, or lacking strength in gray iron. Brake Shoe's experience, research laboratory and experimental foundry are available to help you best utilize its unusual combination of characteristics. Write for your copy of this new technical bulletin today.

Ductalloy castings are made by: BRAKE SHOE & CASTINGS DIVISION
ENGINEERED CASTINGS DIVISION

AMERICAN **Brake Shoe** COMPANY

230 PARK AVENUE
NEW YORK 17 • NEW YORK

ing from 60 to 5000 standard screen size, and the new design permits change-over of abrasive slurry in less than 5 min. Size of abrasive particles, concentration of abrasives in so-

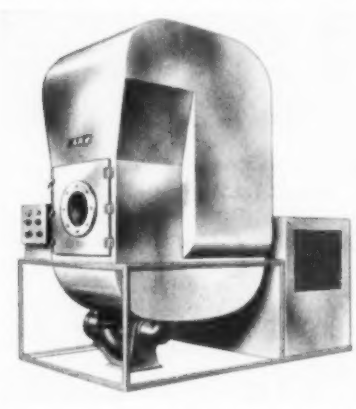


lution, the distance between nozzle and work, and the supply of air pressure can be varied to produce the results desired.

For further information circle No. 12 on literature request card on p. 32-B.

Environmental Testing

A new facility for sand and dust environmental testing has been announced by American Research Corp. The unit is particularly designed to meet MIL-E-5272A and MIL-T-5422A.



A new feature is automatic temperature and dust density control, which for the first time permits tests to be set up for long runs without constant manual regulation.

For further information circle No. 13 on literature request card on p. 32-B.

Nodular Iron

Two new rare earth products are available from Metallurgical Enterprises, for use in the production of nodular (ductile) iron.

For further information circle No. 14 on literature request card on p. 32-B.

Soldering Aluminum

A new fluxing compound for use in soldering aluminum is being distributed by Insulation and Wires, Inc. This new product, known as S-X Aluma-Flux, makes possible the non-corrosive soldering of aluminum alloys (except a few containing high percentages of silicon) as well as the joining of aluminum to other metals. It may be used for manual, dip or mechanical production soldering operations, either in powdered form as delivered, or in molten form with equally satisfactory results.

For further information circle No. 15 on literature request card on p. 32-B.

Magnesium Alloy

The Dow Chemical Co. has announced the availability of a new magnesium alloy ingot patterned to the needs of the commercial magnesium die-casting industry. This alloy, designated as Dowmetal AZ91B, contains beryllium additions for lower melt loss and increased efficiency.

For further information circle No. 16 on literature request card on p. 32-B.

Rust Preventive

Enthone, Inc., has announced Compound NR-31 to prevent rusting of steel, cast iron and other ferrous al-

AMONG A TOOL STEEL SALESMAN'S SOUVENIRS

Here's a punch and a slug — not an unusual punch but one with a history of accomplishment.

A good customer, during the hectic days of World War II, had difficulty getting a 1¾" diameter hole in about 2000 pieces of hot rolled plate 1¼"x8"x8" in a hurry. The finished product was a hook-eye to be welded atop buoys, on a Navy job. Burning and drilling were tried but were too slow. With great apprehension a punch and die were made, using Ziv's PLANCHER Tool Steel. The 2000 holes were promptly punched, cold, without a hitch, and both punch and die were good for a good many more.

While you may not be punching 1¼" thick hot rolled plate, you may have other jobs calling for a tough, resilient tool steel, built to be tough, real tough, then it is wise to use Ziv's PLANCHER Silicon Manganese Tool Steel.

Photo Courtesy of Mesker Bros. Iron Co., St. Louis, Mo.

ESTABLISHED 1911

ZIV STEEL & WIRE CO.

ZIVCO

2945 W. HARRISON STREET • CHICAGO 12, ILL.

BRANCHES

DETROIT, MICH. • ST. LOUIS, MO. • MILWAUKEE, WIS.

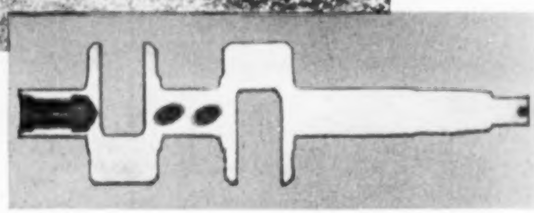
INDIANAPOLIS, IND. • TOLEDO, OHIO • EAGLE RIVER, MICH.

The Evinrude Story:

Salt bath treatment improves product . . . reduces cost in crankshaft production

Savings in machining and grinding operations, due to reduced distortion, are greater than the entire heat treating cost!

Evinrude's new Super Fastwin 15-h.p. outboard motor.



EVINRUDE CRANKSHAFT—Carburize in Park-Kase 1 for 2¾ hours at 1750°F. Case Depth .045". Transfer to Park Nu-Sal Neutral Salt at 1450°F. followed directly by Iso-thermal quench in Park's Thermo-Quench Salt.

AT Evinrude Motors, they combine Park-Kase liquid carburizing and Iso-thermal quenching and tempering into one continuous operation . . . with all processes performed in the same furnace line.

The crankshafts are immersed in Park-Kase liquid carburizer to produce the desired case . . . then transferred to Park Nu-Sal neutral salt at above the critical before the Iso-thermal treatment in Park Thermo-Quench Salt.

RESULTS: a hard case covering a tough core! Valuable production time is saved! But that's not all—

- Less distortion allows less final machining
- Metallurgical properties of part improved
- Process does not require skilled help
- Operate either manually or mechanically
- High capacity per unit of floor space
- Low investment per unit of production

The results are the same at Evinrude as they are wherever Park salt baths and technical assistance is used: quality is improved . . . production is increased . . . manufacturing costs are lowered!

Second in a series of advertisements describing Park processes on the job.

• Liquid and Solid Carburizers • Cyanide, Neutral, and High Speed Steel Salts • Coke • Lead Pot Carbon • Charcoal • No Carb • Carbon Preventer • Quenching and Tempering Oils • Drawing Salts • Metal Cleaners • Kold-Grip Polishing Wheel Cement

Park

PARK CHEMICAL CO.

8074 Military Avenue • Detroit 4, Michigan

☐ Send for free bulletin on Deep Case Liquid Carburizing.

Name____________ Position____________

Company____________

Address____________

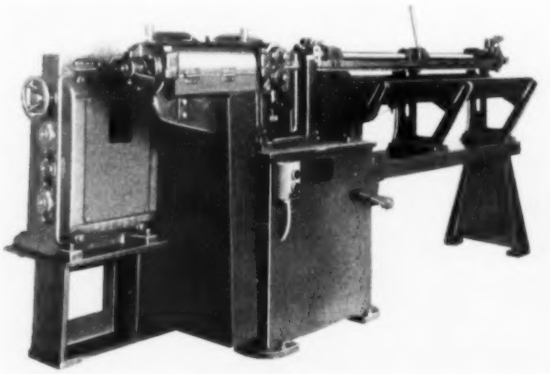
City____________ State____________

loys during storage. The product is a mildly alkaline, water-soluble material used in a concentration of 1 oz. per gal. It leaves almost no visible film on the steel. Tests have indicated that it will protect iron and steel against rusting in 100% humidity for several weeks. The product is readily removed by washing with water.

For further information circle No. 17 on card, p. 32-B.

Wire Straightening

A new model, 1AV, has been announced by Mettler Machine Tool, Inc., manufacturers of Shuster automatic wire straighteners and cutting machines. The 1AV features a variable-speed drive geared to feed infinite speed changes from 50 to 200 ft. per min. The one machine will handle both basic and spring wire. Diameters from $\frac{3}{32}$ to $\frac{1}{4}$ in. basic wire may be straightened and cut and, without



further adjustment than turning the control handle of the variable speed drive, spring wire to $\frac{1}{8}$ in. diameter may also be run through. The variable speed drive enables the operator to compensate for differences of temper, alloy and size and still maintain peak productivity.

For further information circle No. 18 on card, p. 32-B.

Line Burner

A new product now in production by the Eclipse Fuel Engineering Co. is a gas-fired retention-type line burner for applications where heat must be distributed over a wide area by a continuous flame. The new burner is applicable for oven heating, kettle heating and air heating install-

ations, including make-up air systems for spray booths. The burners may be installed to fire in any direction: horizontally, vertically or downward. They are made of cast iron sections with drilled ports and steel retention lips for flame stability.

For further information circle No. 19 on card, p. 32-B.

Three-Dimensional Flame Cutting

The Milwaukee Shipbuilding Corp. has placed on the general market "three-dimensional" flame cutting equipment for scarfing the edges of curved metal pieces in preparation for welded assembly of larger units. The method permits designing increased strength into curved

You Need This New 32 Page Data Book

Anyone concerned with the construction and maintenance of steel plant furnaces, including all kinds of forge furnaces, needs this new 32-page Data Book "Steel Plant Furnace Construction with Ramtite (Plastic Refractory)." It contains details of application and service results for specific constructions such as burner walls, suspended roofs, etc. There is also considerable technical information not previously published that will be of definite interest and of considerable value to ceramic and fuel engineers, as well as mason and operating personnel.

RAMTITE

THE RAMTITE CO.
Division of The S. Obermayer Co.
2551 West 18th Street, Chicago 8, Illinois

Please send a copy of your new 32-page data book.

Company Name ____________
Attn. Mr. ____________ Title ____________
Address ____________
City ____________ Zone ______ State ____________

ACCOLOY—TRADE NAME FOR THE FINEST HEAT AND CORROSION RESISTANT CASTINGS MANUFACTURED

BEFORE YOU BUY ANY CASTINGS, BE SURE TO SEE YOUR NEAREST ACCOLOY ENGINEER FOR

CASTINGS THAT ARE ENGINEERED FOR EFFICIENCY IN DESIGN AND GIVE LONG SERVICE LIFE

Simple as ABC, isn't it—but most effective because these castings show a profit for your production-line schedule.

ALLOY ENGINEERING & CASTING COMPANY

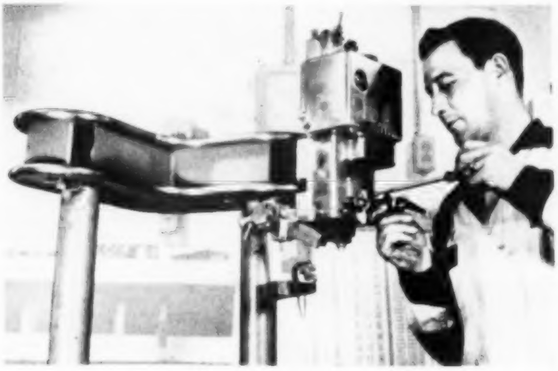
HEAT RESISTANT CASTINGS
ACCOLOY
STAINLESS STEEL CASTINGS

ALLOY CASTING CO. (DIVISION)
CHAMPAIGN, ILLINOIS

ENGINEERS AND PRODUCERS OF HEAT AND CORROSION RESISTANT CASTINGS

metal structures made up of welded parts which themselves are curved. The company calls the flame cutting equipment "three-dimensional" because it operates vertically, horizontally and at angles from the first two as it scarfs the edges of curved metal pieces.

The original application of the "3-D" equipment was in production of curved sections for armed forces tank hulls. At one time the edges of the sections were scarfed with hand-held equipment, but the method was several hundred per cent slower than the semi-automatic "3-D"

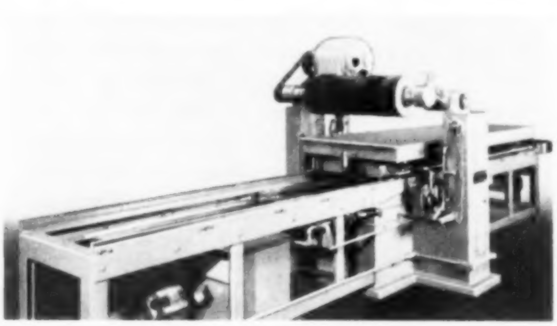


method, and open to deviations from the desired angle. The new equipment centers on a flame cutter which moves under power as it follows the curves of the metal in process. The cutting flame slants at a constant angle from the desired apex of a scarfed edge. A system of twin rails was devised whose rise, fall, tilts and turns match those of the metal under process. Four spring-loaded drive rollers and a spring-loaded idler roller keep the moving unit true to the path of the rails. The drive rollers move at speeds up to 15 in. per min., powered by a 1/25th hp. electric motor. The firm has made a unit big enough to hold a casting measuring 4 by 8 ft., permitting cuts of 16 linear ft. along three sides at an angle of 22° off horizontal. Metal can be cut in thicknesses between ¼ and 8 in. at speeds up to 15 in. per min. for thin stock.

For further information circle No. 20 on card, p. 32-B.

Mechanical Polishing Machine

The Central Machine Works has announced a new series of horizontal polishing machines to their line of hydraulically operated, multi-purpose machines. The



new series permits the polishing of extrusions and sheets the entire length and has an adjustable stroke with stepless increments from 2 in. to the full capacity of the machine (7 to 20 ft.).

For further information circle No. 21 on card, p. 32-B.

NOW—
THE LOWEST COST
Dye Penetrant
Inspection

Spotcheck

by MAGNAFLUX

Ends Guesswork Arguments!

Locates and marks cracks — seams — porosity — laps, etc. — when open to the surface . . . Use it on metals — carbides — plastics — ceramics or practically any other non-porous solid.

Brush—
Dip—
or Spray

Typical casting crack as revealed by Spotcheck in sampling or maintenance inspection.

CHECK THESE LOW PRICES

Quantity	Cleaner Case Lots	Cleaner One Can	Penetrant Case Lots	Penetrant One Can	Developer Case Lots	Developer One Can
12 oz. Pressure Can	(12 cans) $2.00 per can	$4.50 Each	(12 cans) $2.50 per can	$4.50 Each	—	—
Pint Cans	—	—	(12 cans) $2.25 per can	$4.00 Each	(12 cans) $2.00 per can	$4.00 Each
Quart Cans	—	—	(5 cans) $4.00 per can	$6.00 Each	(5 cans) $3.00 per can	$5.00 Each
1 Gal. Cans	(10 gallons) $2.50 per gal.	$3.00 each	(10 gallons) $14.00 per gal.	$15.00 each	(10 gal.) $8.50 per gal.	$9.00 each
5 Gal. Cans	(50 gallons or more) $2.00 per gal.	$2.50 per gal.	(50 gallons or more) $10.00 per gal.	$13.00 per gal.	(50 gal. or more) $7.00 per gal.	$7.50 per gal.

Also complete kits for HANDY SPRAY APPLICATION

$35.00 PLUS $1.00 shipping and handling

Eight assorted cans of Cleaner, Penetrant and Developer, accessories, instruction book and carrying case

All prices f.o.b. Chicago, Illinois. Spotcheck Inspection requires application of Cleaner, Penetrant and Developer. Order quantity desired of each on your company purchase order.

FOR COMPLETE KIT—ORDER NOW

MAGNAFLUX CORPORATION
7346 W. Lawrence Ave., Chicago 31, Ill.

Please send ______ Type SK-1 SPOTCHECK KITS at $35.00 each, plus $1.00 each, packing and shipping cost.

☐ CHECK ENCLOSED. Amount $ ______
☐ Send on our P. O. Number
☐ Send only FREE illustrated bulletin now

Name ______ Title ______
Company ______
Address ______
City ______ Zone ______ State ______

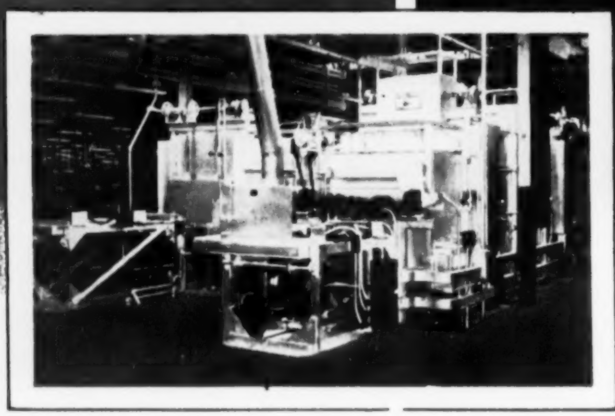
Prices subject to applicable state or local sales tax.

Heat Treating . . .

Automatically

Automatic, continuous heat treat line for hardening, quench, and draw of steel wheels designed and built by Loftus.

Automatic, continuous heat treat line for hardening, quench, and draw of small automobile parts designed and built by Loftus.



Loftus Continuous Heat Treat Lines offer efficient design for handling your product by tray, where the product is loaded and unloaded at one point. Direct, or atmosphere control type furnaces are engineered to render economical, automatic heat treating service. The "Pin-Point Quench" and washer is completely automatic. Construction of "in-line," "square," or rotary layout is dependent upon your individual requirements. Practical, *one operator* units can be built for loads of from 500 to 6000 pounds per hour.

Send today for 16 page Booklet:
"Proven Heat-Treating Efficiency by Loftus."
Shows many furnace types.

Loftus ENGINEERING CORPORATION
Designers and Builders of Industrial Furnaces

610 Smithfield Street, Pittsburgh 22, Pennsylvania

WHAT'S NEW IN MANUFACTURERS' LITERATURE

22. Abrasive Belt Finish
32-page book gives 46 case studies on abrasive-belt methods which saved on machining. *Porter-Cable*

23. Air-Gas Mixer
Bulletin L-700 gives engineering and application data on air-gas proportional mixer. *Eclipse Fuel Engineering*

24. Alloy Steel
16-page book on type 9115 low-alloy high-strength steel. Properties, fabrication, welding. *Great Lakes Steel*

25. Alloy Steel
68-page "Aircraft Steels" booklet includes revised military specifications. Also stock list. *Ryerson*

26. Alloy Steel
Data book on the selection of the proper alloy steel grades for each manufacturer's needs. *Wheelock, Lovejoy*

27. Alloy Steel Castings
Data folders on two types of alloy steel castings. Composition, properties, hardenability bands, uses. *Unitcast*

28. Aluminum Bronze
Bulletin 33 on properties and uses of Ampco metal. *Ampco*

29. Aluminum Die Castings
Bulletin on design and manufacture of aluminum die castings. *Hoover Co.*

30. Aluminum Extrusions
Data on services in the field of aluminum extrusions. *Himmel Bros. Co.*

31. Aluminum Extrusions
28-page book on extruded aluminum products. Design, tolerances, applications. *Revere*

32. Aluminum Heat Treating
8-page Bulletin 5912 on solution heat treating, annealing, stabilizing and aging of aluminum. *General Electric*

33. Ammonia Dissociators
Bulletin on dissociating process gives advantages of ammonia as controlled atmosphere. *Sargeant & Wilbur*

34. Annealing Furnaces
8-page illustrated booklet on continuous annealing furnaces. Schematic diagrams, photographs, and actual production data. *Drever*

35. Atmosphere Furnace
Bulletin on controlled atmosphere furnace. *Industrial Heating Equipment*

36. Atmosphere Furnace
Reprint on bright annealing of copper in atmosphere furnace. *Holcroft*

37. Atmospheres
Bulletin 1-10 supplies technical information on inert gas generators and data on costs. *C. M. Kemp Mfg.*

38. Atmospheres
8-page Bulletin SC-155 discusses following controlled atmospheres: RX, DX, NX, HNX, AX, HX. Compositions, applications, effects on steel, drawings of generators. *Surface Combustion*

39. Barrel Plating
Folder on barrel plating with unique contact arrangement for maximum current distribution. *Daniels*

40. Bending
18-page brochure on bent and welded rings, flanges, angles, bands. Tables of areas of circles, decimal equivalents. *King Fifth Wheel*

41. Bending Aluminum
Bending formulas and radii for 90 and 180° cold bending of various grades and tempers of aluminum. "Technical Advisor No. 18". *Reynolds Metals*

42. Beryllium Copper
Helpful engineering information contained in monthly beryllium copper technical bulletins. *Beryllium Corp.*

43. Black Oxide Finish
Folder on penetrating black finish for ferrous metal. *Puritan Mfg.*

50. Brazing Titanium
Data sheet on use of a new flux for brazing titanium. *Handy & Harman*

51. Bright Carburizing
Job data on bright carburizing and hardening gears. *Ipsen*

52. Bronze
12-page bulletin on properties and uses of continuous cast bronze rod and tube. *American Smelting & Refining*

53. Bronze
Folder gives tables of properties, uses, forms and other data on phosphor bronzes. *Chase Brass & Copper Co.*

54. Buffing and Polishing
Catalog A-50 on five-head rotary machine for automatic polishing and buffing of parts from $\frac{1}{16}$ to 12 in. diameter. *Hammond Machinery*

55. Burner
Catalog 410 describes proportioning oil burner. *Hauck*

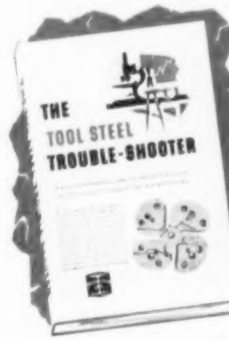
44. Tool Steel Failures

"The Tool Steel Trouble-Shooter"* is a 124-page book, well indexed and cloth bound. Its intended purpose is to solve tool problems from design through operation; 107 tool failures are analyzed and illustrated. It is capably written with a practical approach and has excellent photographs that help identify causes of failures.

The first section shows faults in design that may cause stress concentration failures, heat treating impossibilities, and overloading in service.

Faults in the tool steel are defined and methods of by-passing and modifying such deficiencies are explained. Information on intelligent selection as well as trouble-shooting is given.

Since most tool failures are traceable to improper heat treatment, the book is careful in explaining the reasons for using discretion and care in the heat treatment of tools. The causes and identifying characteristics of improper heat treating are contrasted to their evident remedies and prevention. Since this chapter illustrates that practically all heat treating failures can be avoided by relatively effortless changes in procedures, it is a "must" for all who strive to do only the best job of treating steel.



A few paragraphs on grinding deal with the ultimate effects of hardening history, selection and use of wheels, grinding practices and other factors.

A very interesting section about mechanical and operational factors scrutinizes failures due to stress concentrations, overloads, and heat checks of hot work tools. It evaluates several methods of repairing damaged tools.

*Published by Bethlehem Steel Co. Copies are available at no charge to readers who circle No. 44 on the request card, page 32B.

45. Blackening Compounds
Data on black oxide coatings for steel, stainless steel and copper alloys. *Du-Lite*

46. Blackening Compounds
Bulletin on blackening compounds (for ferrous alloys) to AMS Spec. 2485. *Swift Industrial Chemical*

47. Blackening Stainless
Bulletin on process for blackening stainless steels, cast and malleable irons. *Mitchell-Bradford*

48. Brazed Tubing
12-page data book on brazed tubing made from copper-coated steel. *Bundy*

49. Brazing and Annealing
Bulletin on high speed heating equipment for brazing, annealing, flame hardening, selective heating, heating for forming. *Gas Appliance Service*

56. Burners
16-page bulletin on selection of gas burners. *Western Products*

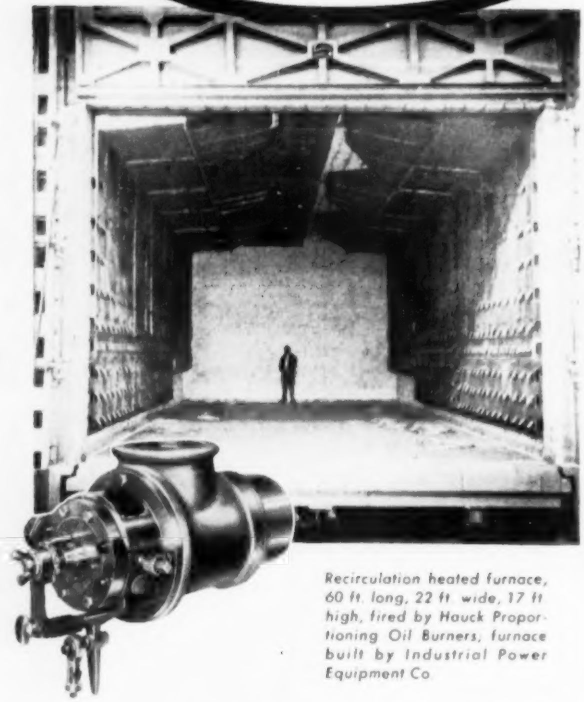
57. Burners
Bulletin 123 on new series of burners for multi-purpose furnaces. *North American Mfg.*

58. Burners
Bulletin R-230 on new series of closed-flame, dual-fuel burners. *Eclipse*

59. Burners
Bulletin on combination gas and oil burner. *Ra-Diant Products*

60. Carbon and Graphite
20-page catalog on carbon and graphite applications in metallurgical, electrical, chemical and process fields. *National Carbon*

Firing a BIG fellow



Recirculation heated furnace, 60 ft. long, 22 ft. wide, 17 ft. high, fired by Hauck Proportioning Oil Burners, furnace built by Industrial Power Equipment Co.

This large furnace is used for stress relieving massive weldments for hydraulic presses and turbines. It requires precise control of combustion conditions, temperature, rate of heating, length of soaking time and rate of cooling.

At the heart of this completely program controlled, recirculation heated furnace are twelve Hauck Proportioning Oil Burners which fire in groups of four into three large air heaters mounted above the furnace. They're mighty important in providing the kind of heating this operation requires.

This is just another among the thousands of furnaces of all types equipped with Hauck Proportioning Oil Burners, the burners that have established a matchless record where heating performance really counts.

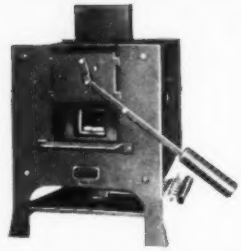
Get the facts about better heating through better firing with Hauck Oil Burners. Write for this Hauck Catalog 410.

HAUCK MANUFACTURING CO.

Combustion Engineers • Manufacturers of Oil and Gas Burners and Equipment

148-158 Tenth Street • Brooklyn 15, N. Y.

"BUZZER" HIGH SPEED *Gas* FURNACES

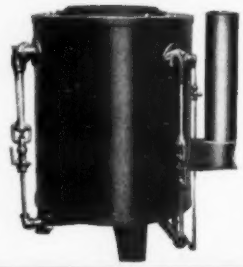


2400° F.

attained quickly with "BUZZER" High Speed Full Muffle Furnaces.

Designed primarily for high carbon and alloy steels.

NO BLOWER or POWER NECESSARY
. . . just connect to gas supply



"BUZZER" Atmospheric Pot Hardening Furnaces assure even heat up to

1650° F.

Used for Salt, Cyanide and Lead Hardening. Also adapted for Melting Aluminum.

Send for the complete "BUZZER" catalog today.

CHARLES A. HONES, INC.

123 So. Grand Ave. Baldwin, L. I., N. Y.

The Metals Handbook

1332 Large Pages
1752 Illustrations
1057 Tables
803 Articles
1,620,000 Words
40,000 copies in use.

Here is a book without a competitor . . . a book 25 years in the making. The current, 7th edition of the Metals Handbook was compiled and written by 68 committees of the American Society for Metals; more than 500 metals engineers were hand picked by the Society as the top experts, the men best qualified to write the most authoritative possible reference book on metals, metal properties, fabrication and uses. The book they wrote is the Metals Handbook. It is divided into 37 principal sections, and contains 803 separate articles and data sheets on metals, metal shaping, forming, heat treating, welding, machining, foundry work, cleaning, finishing, testing, inspection, control and research techniques. All metals, all processes are included. The 64-page index and 4-page section on how to use the book make it easy for any reader to find what he wants. Over 40,000 copies of this edition are now in use by engineers, metallurgists, designers, production men, executives, purchasing agents and others. Order your copy of the 1948 edition today by returning the coupon below. The price is $15.00. Second copy to ASM members, $10.00.

American Society for Metals, Room 903
7301 Euclid Ave., Cleveland 3, Ohio

Rush me a copy of the Metals Handbook.

Name

Company

Address

City Zone State

☐ Check or money order enclosed. ☐ Bill me.

61. Carbon and Sulphur Analysis
Folder on induction furnaces for carbon and sulphur analysis. *Laboratory Equipment*

62. Carbonitriding
Bulletin 241 on gas-fired radiant-tube furnace for carbonitriding and other heat treating. *Lindberg Engineering*

63. Carburizing
Bulletin on deep case liquid carburizing. *Park Chemical*

64. Casting Specifications
Design values for five grades of heat resistant castings. *Ohio Steel Foundry*

65. Castings
20-page bulletin gives standard shapes available in cast iron, brass and aluminum. *Myerstown Foundry & Machine*

66. Cemented Carbides
16-page bulletin gives mechanical and physical properties of carbides for tools and high temperatures. *Kennametal*

67. Chemical Polishing
Data Sheet 32 on new one-minute chemical immersion process for polishing steel. *Macdermid*

68. Chromate Coatings
Folder gives characteristics and uses of chromate conversion coatings on nonferrous metals. *Allied Research*

69. Chromium Plating
"How to Chromium Plate 20 to 80% Faster" describes self-regulating high-speed bath. *United Chromium*

70. Chromium Stainless
12-page book, "Type 430 Stainless Steels as Alternates of the 18-8 Series". Fabrication data, four pages of comparative corrosion ratings for Types 430, 302 and 316. *Republic Steel*

71. Cleaning
6-page bulletin includes concentrations for various metal cleaning applications and a handy list of cleaners for general industrial use. *E. F. Houghton*

72. Cleaning
Story of automatic cleaning operations at Ford Engine Plant. *Metalwash Machinery Corp.*

73. Cleaning
12-page Bulletin 68 deals with factors to consider in selecting metal cleaning equipment. *Despatch Oven*

74. Cleaning Aluminum
12-page bulletin on cleaning process for preparing aluminum and magnesium for welding. *Northwest Chemical*

75. Cleaning Aluminum
Set of seven data sheets on cleaning and finishing of aluminum. *Pennsalt*

76. Cleaning Equipment
Folder on degreaser. Data on different models. *Topper Equipment*

77. Coatings, Metal
High-vacuum evaporation of metals set forth in detail in 12-page booklet. *Consolidated Vacuum Corp.*

78. Cold Finished Bars
Engineering bulletin, "New Economies in the Use of Steel Bars". *LaSalle Steel*

79. Controls
16-page bulletin 18 on meters and controls for processing and other plants. *Bailey Meter Co.*

80. Corrosion Control
8-page booklet on use of nickel-lined pipe and fittings. *Bart Mfg.*

81. Corrosion of Copper
28-page booklet B-36 discusses corrosive attack on copper and copper alloys. Tabulation of their relative corrosion resistance. *American Brass*

82. Corrosion Prevention
Bulletin No. 730 on plastic paint for protection of metal surfaces exposed to acids, alkalies, oils, waters, alcohols. *U. S. Stoneware*

83. Cut-Off Wheels
Folder gives data, operating suggestions and grade recommendations of cut-off wheels. *Manhattan Rubber Div.*

84. Cutting Compounds
Data on cutting compounds for stainless and titanium. *Hangsterfer's Labs.*

85. Cutting Off
8-page bulletin on circular saw blades for cutting off. *Motch & Merryweather*

86. Cutting Oil
Facts on more efficient and economical plant operation through use of right lubricants described in "Metal Cutting Fluids" booklet. *Cities Service*

87. Nonferrous Alloys
132-page Specification Handbook, 5th edition, covers brass, bronze, aluminum, lead and tin-base alloys. Compilation of

specifications issued by Government agencies and technical societies. Also test bar data, tables of foundry and other information. *North American Smelting*

88. Cutting Oil
New pamphlet on sulphurized oil applicable to stainless steel and more easily machined alloys. *Gulf Oil*

89. Cutting Oil Chart
Selection chart for seven classes of metal in nine machining operations. *Aldridge Industrial Oils*

90. Descaling Process
8-page bulletin on sodium hydride descaling process for ferrous and nonferrous metals. *Du Pont*

91. Descaling Stainless Steel
Bulletin 25 on descaling stainless steel and other metals in molten salt. *Hooker Electrochemical*

92. Dew-Point Recorder
Bulletin 407 and Data Sheet AED 340-7 on dew-point systems for recording or controlling. *Foxboro*

93. Die Casting
Bulletin 103 describes new cold chamber die-casting machine with capacity of 9.5 lb. of aluminum. *Lewis Welding & Engineering*

94. Dipping Baskets
Bulletin describes 20 types of cleaning, dipping and degreasing baskets. *Hoffman Co.*

95. Ductile Iron Castings
12-page bulletin on pearlitic, ferritic and austenitic grades of ductile iron. Properties, 12 typical uses. *American Brake Shoe*

96. Electric Furnaces
Brochure on electric heat treating, melting, metallurgical tube, research and sintering furnaces. *Pereny Equipment*

97. Electrical Steel
80-page book of engineering data on silicon steels for the electrical industry. *Republic Steel*

98. Electroforming
Folder on uses and advantage of electroforming. *Bone Engineering Corp.*

99. Electropolisher
Bulletin on theory and practice of electrolytic polishing of metallurgical samples. Description of electropolisher. *Buehler, Ltd.*

100. Enamel Coatings
Reprint gives data on thin porcelain enamel coatings on aircraft exhaust systems. *Porcelain Enamel Inst.*

101. Fabrication Data File
Reference file of engineering information about equipment and processes used for stampings, heavy weldments and pressed steel shapes. *Brandt*

102. Fasteners
32-page booklet on 28 fastener problems and how solved. *Elastic Stop Nut*

103. Fasteners
40-page booklet on complete line of fasteners, their construction, uses, variations. *Simmons Fastener Corp.*

104. Fatigue of Magnesium
18-page paper, "Plastic Flow and Work Hardening Phenomena in Magnesium Alloys During Fixed-Deflection Fatigue Tests". *Dow Chemical*

105. Ferro-Alloys
64-page book describes over 50 metals and alloys produced by the company. *Electro Metallurgical*

106. Finishing
Bulletin on continuous filtration for paint spray booth water. *Industrial Filtration Co.*

107. Finishing
Brochure on cleaners, phosphating compounds, spray booth materials, paint stripping operations. *Pelron*

108. Finishing Systems
Bulletin on cleaning and rust-proofing equipment, spray booths and drying ovens. *Peters-Dalton*

109. Flaw Detection
12-page bulletin on location of flaws by two dye-penetrant inspection methods. *Turco Products*

110. Flow Meters
Bulletin 201 on flow meter for gas used in heat treating. *Waukee Eng'g.*

111. Flow Meters
24-page manual on application and installation of indicating flow meter. *Meriam Instrument*

112. Flux, Aluminum Melting
Data sheet on four fluxes for degassing and purifying aluminum alloys. *Atlantic Chemicals & Metals*

113. Forced Convection
Bulletin T-19 on forced-convection furnace for heat treating. *Ipsen*

114. Forgings
Handsome 32-page brochure on large forgings for turbine shafts, rotors, drop hammer anvils, rolls. *U. S. Steel*

115. Forgings
32-page engineering manual of brass and aluminum forgings. *Mueller Brass*

116. Forming Dies
Data on roller dies for forming tubes and rolled shapes. *American Roller Die*

117. Foundry Practice
Article on gates and risers with reference to nonferrous practice. *R. Lavin*

Carburize Gears in HEVI DUTY FURNACES

Western Gear Works, a leading manufacturer of high quality aviation gears, uses Hevi Duty Vertical Retort Furnaces to carburize and normalize. These furnaces are required to treat many sizes of special gears made from a variety of steels including Boron Steel.

G. R. Leghorn, Chief Metallurgist of the Western Gear Belmont Plant, says, "Using these furnaces with zone temperature control and forced circulation of the carburizing atmosphere inside the sealed retort, we are always sure the gears will be treated to the exact case depths and carbon concentrations required."

You, too, can produce consistently uniform results if you specify Hevi Duty Vertical Retort Furnaces for Carburizing, Nitriding, Dry Cyaniding, and Bright Annealing.

HEVI-DUTY

Write for Bulletin 646.

HEVI DUTY ELECTRIC COMPANY

MILWAUKEE 1, WISCONSIN

Heat Treating Furnaces . . . Electric Exclusively

Dry Type Transformers *Constant Current Regulators*

118. Foundry Practice
Bulletin on unit for curing intricate cores by dielectric heat. *Allis-Chalmers*

119. Foundry Supplies
28-page Catalog 1043C on oil and gas-burning equipment for cupola lighting, mold drying, ladle heating, core baking, furnace heating. *Hauck*

120. Free-Machining Steel
8-page booklet on new free-machining cold finished steel. Eight case histories. *Jones & Laughlin*

121. Furnace Belts
44-page catalog describes metal belts for quenching, tempering, carburizing and other applications. *Ashworth Bros.*

122. Furnace Controls
Bulletin on instruments and controls for heat treating furnaces. *Hays Corp.*

123. Furnace Fixtures
Bulletin 111 on cast Ni-Cr fixtures for gas carburizing. *Fahralloy*

124. Furnace Maintenance
16-page "Maintenance Guide for Electric Heat Treating Furnaces" on preventive program. *Hevi Duty Electric*

125. Furnaces
Catalog and parts manual of kilns and electric furnaces. *L & L Mfg. Co.*

126. Furnaces
Bulletin 433 on electric, convection-type pit furnaces for air drawing, tempering, aging, annealing. *W. S. Rockwell*

127. Furnaces
Bulletin describes 18 electric furnaces for research and small-scale production, with operating temperatures to 3000 F. *Harper Electric Furnace*

128. Furnaces
44-page Catalog 112, well illustrated, features furnaces for hardening, tempering, carbonitriding, forge heating, sintering, annealing and tool heat treating. Also atmosphere generators and ammonia dissociators. *C. I. Hayes*

129. Furnaces
12-page Catalog I-2 on method of atmospheric control for hardening high speed steel. *The Sentry Co.*

130. Furnaces
40-page book describes gas and electric furnaces and applications. Four basic types of atmospheres. Glossary of heat treating terms. *Westinghouse*

131. Furnaces, Heat Treating
Catalog on furnaces for tool room and general-purpose heat treat. *Cooley*

132. Furnaces, Heat Treating
Bulletin on fuel and electric furnaces for heat treating. *Dempsey*

133. Furnaces, Heat Treating
12-page bulletin on conveyor furnace, radiant tube gas heated, oil or electrically heated. *Electric Furnace Co.*

134. Furnaces, Heat Treating
32-page catalog on high-speed gas furnaces for heat treating carbon and alloy steels; also pot furnaces for salt and lead hardening. *Chas. A. Hones*

135. Furnaces, Laboratory
26-page "Construction of Laboratory Furnaces" contains many diagrams, charts, tables, and information on how to construct furnaces. *Norton Co.*

136. Furnaces, Small Tool
Folder describes complete set-up for heat treatment of small tools, including draw furnace, quench tank and high temperature furnace. *Waltz Furnace*

137. Galvanizing
Bulletin on galvanizing furnaces and equipment. *Furnace Engineers*

138. Galvanizing
4-page folder on recommendations for the proper preparation of materials prior to hot dip galvanizing. *American Hot Dip Galvanizers Assoc.*

139. Gold Plating
Physical, thermal, chemical, electrical, diffusion and optical properties of electroplated gold. Uses. *Technic, Inc.*

140. Gold Plating
Folder on salts for bright gold plating. Also lists equipment needed. *Sel-Rex*

141. Grainal Steel
6-page article on use of grainal as boron-additive alloy and properties of grainal steels. *Vanadium Corp.*

142. Hard Surfacing
40-page Hard-Facing Manual tells what metals can be hardfaced, how to select right hardfacing material, lists step-by-step procedures and industrial applications. *Haynes Stellite*

143. Hard Surfacing
16-page bulletin gives applications, 14 case histories of Electrolizing process. *Electrolizing Corp.*

144. Hardening Stainless
24-page "Story of Malcomizing" describes surface hardening of stainless steels. *Lindberg Steel Treating Co.*

145. Hardness Conversion
Wallet-size celluloid card gives hardness and tensile conversions. *International Nickel*

146. Hardness Tester
Circular on portable hardness tester in sizes for work 1 to 6 inches round and flat. *Ames Precision*

147. Hardness Tester
4-page bulletin on Brinell hardness tester weighing 26 lbs. for portable and stationary use. *Andrew King*

148. Heat Resisting Alloy
Pyrasteel bulletin describes chromium-nickel-silicon alloy for service economy in resisting oxidation and corrosion to 2000 F. *Chicago Steel Foundry*

149. Heat Resisting Alloy
Bulletin 1052 on properties of alloy for 1800 F. and higher. *Kennametal, Inc.*

150. Heat Treat Baskets
Bulletin describes 10 types of heat treating baskets. *Hoffman Co.*

151. Heat Treat Loader
Bulletin on equipment for loading metered quantities of parts into heat treating furnaces. *Michigan Crane and Conveyor*

152. Heat Treating
72-page catalog on carburizing, cyaniding, brazing, austempering and annealing processes. *Ajax Electric*

153. Heat Treating
12-page bulletin on heat treating in a steam atmosphere. *Leeds & Northrup*

154. Heat Treating Aluminum
Bulletin 14-T on ovens for heat treatment of aluminum and other low-temperature processing. *Young Bros.*

155. Heat Treating Ammonia
24-page "Guide for Use of Anhydrous Ammonia" describes heat treating and other metallurgical uses. *Nitrogen Div., Allied Chemical & Dye*

156. Heat Treating Fixtures
24-page catalog on heat and corrosion-resistant equipment for heat treating and chemical processing. 30 classifications of equipment. *Pressed Steel*

157. Heat Treating Fixtures
24-page catalog B-8 on muffles, retorts, baskets, other fixtures for heat treating in gas or salt baths. *Rolock*

158. Heat Treating Furnaces
8-page bulletin illustrated 14 types of furnaces. *Lee Wilson Contracting Co.*

159. Heat Treating Guide
Chart guide constructed on slide rule principle for simplified hardening and drawing of tool steels. *Carpenter Steel*

Harden Piston Rings with HEVI DUTY BOX FURNACES

U. S. Hammered Piston Ring Company of Stirling, New Jersey, manufacturers of aviation piston rings, found that very close tolerances could be met when hardening their rings in Hevi Duty Furnaces.

These furnaces operating 24 hours a day treat thousands of rings in size from 1 to 33 inches in diameter.

Leo Maren, Plant Superintendent, says, "I have used Hevi Duty Furnaces for over 20 years. I like the even heat and uniform temperatures afforded by the heating elements located on the six sides of the work chamber."

Learn more about the many features that are designed into Hevi Duty Box Furnaces.

Write for Bulletin 441. HEVI DUTY

HEVI DUTY ELECTRIC COMPANY

MILWAUKEE 1, WISCONSIN

Heat Treating Furnaces . . . Electric Exclusively

Dry Type Transformers *Constant Current Regulators*

160. Heliarc Welding
Pocket-sized folder contains current ranges and sizes for electrodes with table on current and number of passes required to weld various metals. *Linde*

161. High-Temperature Alloy
Property data for 21% Cr, 9% Ni heat-resistant alloy. *Electro-Alloys Div.*

162. High-Temperature Alloys
High temperature work sheet provides valuable suggestions for solving high temperature problems in design and production. *International Nickel*

163. High-Temperature Belts
24-page bulletin on metal conveyor belts. *Wickwire Spencer*

164. Fabricating Stainless Steel
36-page book covers nine methods for cold forming of stainless steel; also machining, riveting, forging, annealing, pickling, polishing, etching, painting, coloring, passivation. *Republic Steel*

165. High-Temperature Steels
87-page book on factors affecting high-temperature properties. 45 pages of data on tensile, creep and rupture properties of 21 high-temperature steels. *U. S. Steel*

166. High-Tensile Steel
Bulletin on nickel-copper steel of low-alloy, high-strength type. *Youngstown Sheet and Tube*

167. High-Vacuum Pumps
36-page Catalog 750 gives formulas, constants, conversions used in vacuum work, pump selection data. *Stokes*

168. Identifying Stainless
Cardboard chart outlining systematic method for rapid identification of unknown or mixed stocks of stainless steels. *Carpenter Steel*

169. Illium
Data on corrosion resistance, strength and workability of Illium alloy. *Illium*

170. Immersion Heater
Catalog on heater features application data for calculating power requirements for heat processing tanks. *Cleveland Process Co.*

171. Impregnating Castings
8-page bulletin on impregnating porous castings. Properties of impregnant. *American Metaseal*

172. Impregnation of Castings
Report M-10 on impregnation costs, amortization, results. *Seal Cast Co.*

173. Induction Heat Control
Data sheet on radiation pyrometer for direct measurement of work being induction heated. *Leeds & Northrup*

174. Induction Heat Control
Sheet 83 on miniature radiation-detecting temperature-measuring device for flame hardening and induction heating. *Minneapolis-Honeywell*

175. Induction Heating
Bulletin on new 60-cycle induction furnace for heating aluminum, magnesium, copper and brass for forging, extrusion and rolling. *Loftus Eng'g.*

176. Induction Heating
Data folder on megacycle tube-type machines for soldering, brazing, hardening. *Sherman Industrial Electronics*

177. Induction Heating
"Induction Heating" . . . presents case histories of increased production, reduced space, lower costs. *Westinghouse*

178. Induction Heating
Catalog MP-2 describes portable high frequency induction heating unit for brazing, hardening, soldering, annealing and melting. *Lepel High Frequency*

179. Induction Melting
8-page article describes use of induction melting in improved technique for rotor-casting. *Ajax Engineering*

180. Industrial Finishing
Catalog A-653 gives complete story on planning industrial finishing systems and shows many installations of cleaning and pickling machines. *R. C. Mahon*

181. Stainless Bars
28-page technical book on stainless steel bars includes processing information about cutting, welding, forging, upsetting, machining, and heat treating. Corrosion and other property data tabulated. *Allegheny Ludlum*

182. Inert Gas Welding
Heliwelding, inert-gas-shielded arc-welding process for all-position welding of aluminum, magnesium, stainless steel, brass and copper, in ADC-709, Catalog 9. *Air Reduction*

183. Inspection
Illustrated bulletin on Spotcheck, new dye-penetrant method for locating surface defects. *Magnaflux*

184. Investment Castings
Production techniques, design, accuracy, advantage of investment casting. *Arwood Precision Casting*

185. Laboratory Furnaces
Data sheets on complete line of laboratory furnaces for metallurgical operations. *Boder Scientific*

186. Laboratory Furnaces
Folder describes and illustrates tubular furnace for use in tensile testing, and control panels. *Marshall Products*

187. Laboratory Safety
48-page book includes data, techniques and equipment, with useful manual for setting up complete laboratory safety programs. *Fisher Scientific*

188. Liquid Carburizing
Bulletin gives case depth and hardness vs. time of carburizing; also timing chart for neutral salt baths. *Bellis*

189. Lubricant
Uses of colloidal graphite for hot metalworking operations (deep piercing, forging, stretch forming and wire drawing operations). *Acheson Colloids*

190. Lubrication
24-page illustrated bulletin gives history of 100 years progress in cutting oils, core oils and lubricants. *Swan-Finch Oil Corp.*

191. Machining Titanium
Recommendations for turning, milling, drilling, tapping and grinding titanium. *Mallory-Sharon*

192. Magnesium
42-page booklet on wrought forms of magnesium. Includes 31 tables. *White Metal Rolling & Stamping*

193. Magnesium Specs
Bulletin DM12 on specifications of government agencies, AMS, SAE, ASTM. *Dow Chemical*

194. Magnets
Folder on lifting magnets gives sizes, lifting capacity and electric current necessary. *O. S. Walker*

195. Malleable Iron
Reprint 51-B on metallurgy, treatment, and heat treated properties of malleable iron. *Surface Combustion*

196. Malleable Iron
12-page Bulletin 5797 on electric-furnace annealing of malleable iron. *General Electric*

197. Marking Devices
20-page indexed catalog on marking devices and equipment. *Newark Stamp and Die Works*

198. Material Handling
Bulletin 100 on plate lifting clamps. *Smith Material Handling Devices*

199. Meehanite Castings
8-page bulletin on five engineering grades of Meehanite. Hardenability, other properties, uses. *American Brake*

200. Melting Aluminum
Bulletin 310 on furnaces for melting aluminum. *Lindberg Engineering*

201. Metal Analysis
Brochure on Quantometer, which furnishes pen-and-ink records of quantitative spectrochemical analyses with extra copies. *Applied Research Labs.*

202. Metal Cleaners
Bulletin B-8 gives tabular data on 15 metal cleaners. *Apothecaries Hall*

203. Metal Cutting
64-page catalog No. 29 gives prices and describes complete line of rotary files, burrs, metalworking saws and other products. *Martindale Electric*

204. Metallograph
40-page brochure on Vickers research metallograph. *R. Y. Ferner*

205. Metallograph
20-page book on desk-type metallograph. *American Optical*

206. Microhardness Tester
Bulletin describes the Kentron microhardness tester. *Kent Cliff Laboratories*

207. Microhardness Tester
Bulletin DH-114 on Tukon hardness testers in research and industrial testing. *Wilson Mechanical Instrument*

208. Micrometer
Bulletin 652 on micrometer for finding center-to-center distances. *Sorensen Center Mikes, Inc.*

209. Microphotometers
12-page catalog on microphotometers for spectrographic and other uses. *Leeds & Northrup*

210. Moly-Sulphide Lubricant
40-page booklet on Moly-sulphide lubricant gives case histories for 154 different uses. *Climax Molybdenum*

211. Nickel Cast Iron
Booklets entitled "Engineering Properties and Applications of Ni-Resist", and "Buyers' Guide for Ni-Resist Castings". *International Nickel*

212. Nitriding Furnace
28-page Bulletin 646 on carburizing and nitriding furnace giving atmosphere circulation to 1850° F. *Hevi Duty*

213. Nondestructive Testing
Data on equipment for inspection and sorting. *Magnetic Analysis*

214. Nonferrous Castings
20-page Catalog 53 on aluminum, magnesium and bronze castings. *Wellman Bronze & Aluminum*

215. Nonferrous Melting
12-page bulletin on eight types of gas furnaces for melting nonferrous metals. *Bellevue Industrial Furnace*

216. Nonferrous Metals
"Metal of the Month" letters include market trends, statistics, helpful data. *Belmont Smelting & Refining*

217. Nonferrous Wire
Folder gives wire gage and footage chart and data on beryllium copper, phosphor bronze, nickel, silver, brass and aluminum wire. *Little Falls Alloys*

218. Oil Quenching
Catalog V-1146 on self-contained oil cooling equipment. Selection tables for volume of oil required and oil recirculation rates. *Bell & Gossett*

219. One-Minute X-Ray
Reprints on Land-Polaroid method of X-ray film processing. *Picker X-Ray*

220. Phase Contrast
16-page Bulletin D-104 on theory, applications and equipment for phase contrast microscopy. *Bausch & Lomb*

221. Phosphate Coating
16-page bulletin on phosphatizing machine and other finishing equipment. *Cincinnati Cleaning & Finishing Mach.*

222. Pickling Baskets
Data on baskets for degreasing, pickling, anodizing and plating. *Jelliff*

223. Pickling Baskets
12-page bulletin on mechanical picklers, crates, baskets, chain and accessories. *Youngstown Welding & Eng'g.*

224. Piercing
Slide calculator for determining the required pressure (in tons) for piercing a given size hole in any thickness and type of metal. *Ward Machinery*

225. Piezotronics
20-page brochure on applications of piezoelectric materials. *Brush Electronics*

226. Plating
8-page booklet on plating rack designed to make spline section or body of rack a permanent tool. *National Rack*

227. Plating
Booklet on chemical plating process for applying nickel to difficult-to-plate parts. *Gen. Am. Transportation*

228. Plating Solutions
Bulletin 12 on electric heating of pickling and plating solutions. *Pyrosil*

229. Plating Wastes
8-page reprint on ion exchange treatment of plating wastes. Cost comparison. *Permutit Co.*

230. Polarizing Microscopes
40-page book on polarizing microscopes, universal stages, other accessories. *E. Leitz*

231. Polishing
Catalog A-60 on polishing lathes up to 3600 rpm. *Hammond Machinery*

232. Powder Metallurgy
12-page "Prealloyed Stainless Steel Powders—Properties, Production, Uses". Types 302B, 316, 318, 318Si, 431. *Vanadium-Alloys Steel*

233. Powder Metallurgy
Information on sponge iron powder. *Ekstrand & Tholand*

234. Powder Metallurgy
Data on annealed carbonyl iron powders, hydrogen reduced iron powders and Magna-tites. *Magnetic Powders*

235. Powder Metallurgy
Reprint on high density iron powders, their structure and processing. *Plastic Metals Div.*

236. Precision Casting
Discussion of alloy selection and design of investment castings. *Arwood Precision Casting*

237. Precision Casting
Bulletin on mechanically-operated induction furnace for precision casting. *Ajax Electrothermic*

238. Precision Casting
44-page Catalog 53 covers every stage of the investment casting process. *Alexander Saunders*

239. Press Applications
20-page bulletin shows variety of press applications. *Hydraulic Press Mfg.*

240. Pressure, Vacuum Gages
32-page Catalog 7001 on gages for vacuums to 10^{-6} mm. Hg and pressures to 150,000 psi. *Minneapolis-Honeywell*

241. Pure Metals
Data sheets on vacuum melted cobalt, copper, iron and nickel. *Vacuum Metals*

242. Pyrometers
12-page Bulletin 713 on indicating and controlling pyrometers. Functional diagrams of installations. *Gen. Electric*

243. Pyrometers
Data on indicating pyrometers and dial-type thermometers for immersion use to 1500° F. *Seico*

244. Pyrometers
Data sheets on high resistance indicating pyrometers. Also controls and resistance thermometers. *West Instr.*

245. Quenching
Bulletin 820 on automatic quenching tanks for use with continuous heat treating equipment. *Am. Gas Furnace*

246. Quenching
Data sheet on mixer for agitation of quenching liquids. *Chemineer*

247. Quenching Oil
8-page booklet on applications and cost reductions in oil-quenching installations. *Sun Oil*

248. Radiant Heat
Folder on flameless incandescent gas burner for drying, heating, heat treating. *Granco*

249. Radiation Detectors
Specification Sheet 84 on Radiamatic compensated radiation detectors for use with variety of pyrometric instruments. *Minneapolis-Honeywell*

250. Radiography
16-page bulletin on materials and accessories for radiography. Density curves for four types of films. *X-Ray Div., Eastman Kodak*

251. Radiography
Bulletin 400-310 on self-contained X-ray unit for mass production inspection of parts. *Westinghouse*

252. Recorder
Bulletin C2-2 on electronic strip chart recorder for temperature, speed, static strain, voltage, amperage. *Wheelco*

253. Refractories
12-page brochure on products for

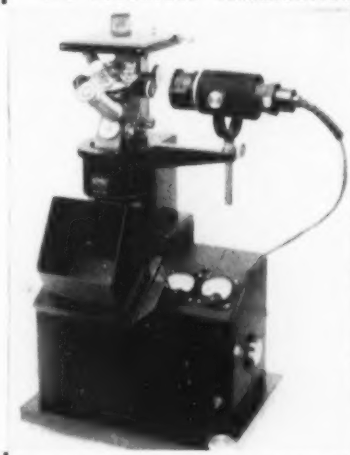
(Continued on p. 32A)

new the UNITRON

METALLOGRAPH

and Universal Camera Microscope

VISUAL OBSERVATION and PHOTOGRAPHY
OPAQUE and TRANSPARENT SPECIMENS
BRIGHT FIELD, DARK FIELD and POLARIZED ILLUMINATION



This is the instrument all metals engineers are talking about. Instantly converted for transparent specimens using the transmitted light accessories (included but not illustrated). Units of comparative quality, versatility, and performance cannot be obtained for less than twice the price!

- the image is automatically in focus in the camera—the transition from observation to photography is instantaneous
- compact and entirely self-contained with built in 3¼" x 4¼" camera, light, variable transformer.
- complete range of magnification: 25–1500× visually, 37–2250× photographically. Equipped with 5 objective lenses and revolving nosepiece, 3 photographic eyepieces on revolving turret, 3 visual eyepieces.
- many other important features and accessories including calibrated mechanical stage, filters, polarizing apparatus, micrometer eyepiece, film holders, hardwood case, etc.

f.o.b. Boston COMPLETE UNIT Only $940

Metallurgical Microscope MMU

Model MMU pioneers several new features available for the first time, as well as including features found only in instruments selling for over twice our unusually low price. For metals and other opaque specimens and also transparent specimens, under both ordinary and polarized light. An ideal, all-purpose, laboratory instrument. 25–1500×.

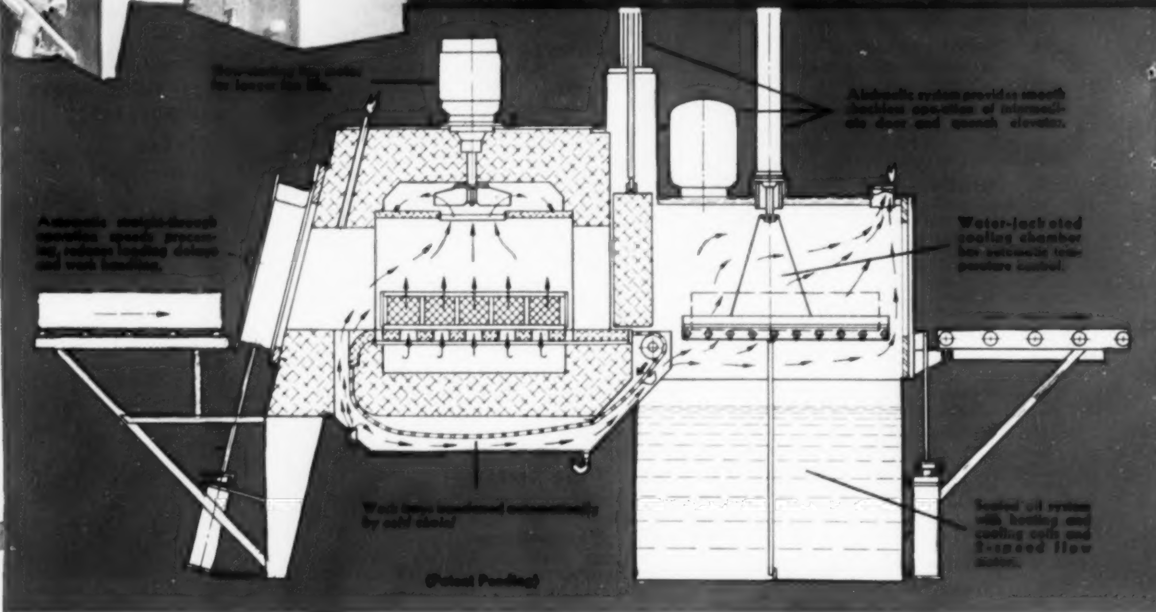
- transformer built into microscope base
- vertical illuminator with iris diaphragm and filters
- illuminator mounts on stage for oblique lighting
- illuminator mounts substage for transparent specimens
- coarse and fine focusing
- focusable stage
- calibrated drawtube
- polarizing apparatus
- revolving nosepiece with objectives 5×, 10×, 40×, 100×
- eyepieces: P5×, P10×, K15×

COMPLETE with all accessories, f.o.b. Boston Only $287

Write to Dept. P-7 for illustrated literature

United Scientific Co.
204-206 MILK STREET, BOSTON 9, MASS.

YOU GET *Uniform Results* with Ipsen 100% FORCED CONVECTION CONTROLLED ATMOSPHERE UNITS



SIMPLE CHANGE-OVERS
Change-over from one process to another is simple, quick, and easy. Settings for heat, atmospheres, quench and oil flow is all that is required. Cycle is then controlled automatically.

★Above is a cross-section view of the Ipsen 400 Lb./Hr. Furnace showing the advanced design features which have made Ipsen the largest manufacturer of carbonitriding and batch-type heat treating units. With these new units, you get the advantages of 100% forced convection heating and controlled atmosphere processing, *plus* the full benefits of automatic straight-through operation. Thus, you eliminate loading delays and guess-work. You control distortion and get uniform results from batch to batch . . . today, tomorrow, or next year. You eliminate blasting and pickling operations and you can often use lower grade, less costly steels.

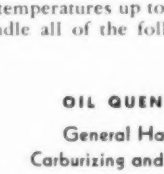
A SINGLE UNIT HANDLES ALL OF THESE OPERATIONS

Unusually versatile, the Ipsen is built for temperatures up to 1850° F., and a single unit is equipped to handle all of the following processes:

ATMOSPHERE COOLING	OIL QUENCHING
Normalizing	General Hardening
Stress Relieving	Carburizing and Hardening
Carburizing	Carbonitriding
Carbonitriding	Martempering

Send **Samples for Free Estimate** — find out how the new Ipsen Units can be applied to your job. Samples of your work will be run, procedures established in our new, modern lab, and cost estimates given without obligation.

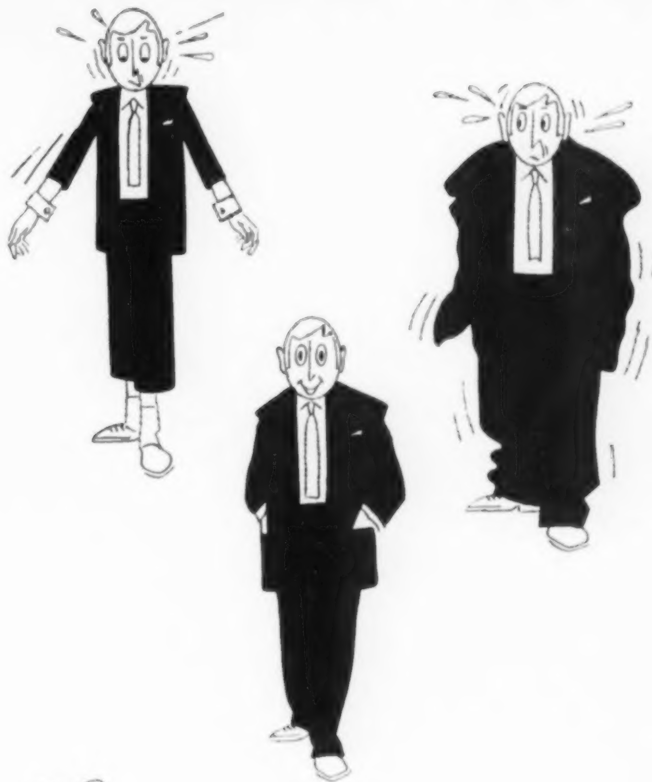
Write **for New Literature** — illustrates new design features, gives complete specifications of various units.



MORE THAN 375 IPSEN HEAT TREATING UNITS ARE NOW SERVING INDUSTRY

AUTOMATIC Ipsen

IPSEN INDUSTRIES, INC. 723 South Main Street; Rockford, Illinois
Universal Units to CARBONITRIDE • CARBURIZE • HARDEN • BRAZE • MARTEMPER • WASH • TEMPER



Like the right size suit

CMP THINSTEEL TRADE MARK *is tailored to your need*

Buying steel is very much like buying a suit—you prefer to buy the steel or the suit that EXACTLY fits your requirements. True, any item made to fit a particular need may cost a little more than a product offered for all-purpose usage; but the first cost, particularly the "first steel cost," may be relatively unimportant. The end-product cost is the most important consideration. If cold rolled strip or spring steel is involved in fabrication of component parts for your end-products, and the labor cost for fabricating and assembling those component parts is an important part of your total cost, you'll want to investigate CMP strip products.

CMP strip can be made to fit the most exacting needs, whether it be in terms of close tolerances, uniformity of structure, temper, finish or physical properties. The use of specially prepared CMP strip made to the measure of a particular processing or end-product requirement is contributing to lower total costs for many manufacturers. We'll welcome the opportunity to "try CMP strip for size" in your fabricating or assembly operations. Don't compromise steel quality for first steel cost.

the Cold Metal Products co.

YOUNGSTOWN 1, OHIO

New York • Chicago • Indianapolis • Detroit • St. Louis • Los Angeles • Cleveland

LOW CARBON, HIGH CARBON** (Annealed or Tempered) **STAINLESS AND ALLOY GRADES, ELECTRO ZINC COATED ARE AVAILABLE FROM:

THE COLD METAL PRODUCTS CO. of CALIFORNIA, 6600 McKinley Avenue, Los Angeles
Phone: PLeasant 3-1291

THE KENILWORTH STEEL CO., 750 Boulevard, Kenilworth, New Jersey
Phones: N. Y., COrtlandt 7-2427; N. J., UNionville 2-6900

PRECISION STEEL WAREHOUSE, INC., 4425 W. Kinzie, Chicago • Phone: COlumbus 1-2700

(Continued from p. 31)
casting special refractory shapes and for gunning and troweling applications, for services to 3000 F. *Johns-Manville*

254. Refractories
20-page booklet gives technical information on super refractories. Charts, tables and application data. *Refractories Div., Carborundum Co.*

255. Refractories
32-page data book on plastic refractory and its use in steel plant construction. *Ramtite*

256. Refractory Cement
Bulletin discusses refractories and heat-resistant concrete. *Lumnite Div.*

257. Refractory Skids
Booklet on Carbofrax rails for annealing furnaces. *Refractories Div., Carborundum*

258. Roll Formed Shapes
24-page Bulletin 1053 on designing, forming and producing shapes from ferrous and nonferrous metals. *Roll Formed Products Co.*

259. Rust Preventives
12-page bulletin on water-soluble rust-preventive. *Production Specialties*

260. Rust-Proofing
Literature on rust-proofing ferrous metal parts. *American Chemical Paint*

261. Rust Removal
Booklet on rust and tarnish removal. Instructions on use of six new products. *Octagon Process, Inc.*

262. Safety Valves
Bulletin 400 on safety valves for shutting off fuel in case of power failure to essential unit. *Western Products*

263. Salt Bath Furnaces
Data on salt bath furnaces for batch and conveyorized work. *Upton*

264. Salt Baths
32-page bulletin on salts for tempering, annealing, neutral hardening, martempering and carburizing. Heat treating data. *E. F. Houghton*

265. Sand Control
32-page book on defects and troubles in foundry and how to remedy through sand control. *Claud S. Gordon Co.*

266. Screw Machine Products
64-page buyers' guide to companies available for contract work. Equipment available, secondary services and specialties. *N.S.M.P.A.*

267. Shearing
16-page catalog on pivoted-blade shears for cutting metal up to 1.25 in. thick. *Cleveland Crane & Engineering*

268. Sheet Metal Testing
8-page folder on equipment for testing the drawing, stamping and folding qualities of sheet and strip. *Deakin*

269. Shell Molding
Folder on carbon equipment used in shell molding process. *Speer Carbon*

271. Arc-Welding Electrodes

50-page pocket guide describes electrodes of stainless, mild and high-tensile steels, cast iron, nonferrous alloys, low-hydrogen and hardfacing compositions. Also sections on picking the right electrode, mechanical properties and testing of electrodes, and AWS-ASTM specifications. *Air Reduction*

270. Shot and Grit
Handy calculator has size data for SAE grades of shot and grit. *Pangborn*

272. Shot Peening
24-page book gives 21 applications of shot peening, 37 references. *Metal Improvement Co.*

273. Shot Peening
Selection and use of shot and grit for peening. *Cleveland Metal Abrasive*

274. Silver Brazing
10-page technical bulletin on brazing preforms. Specifications for 13 types of joints. *Lucas-Milhaupt*

275. Silicon Bronze
Article on silicon bronze from "I
got Technical Journal". *Lavin*

276. Solder
Leaflet on rosin core solder.
sizes, compositions and quantities
erated Metals

277. Soldering Irons
Folder on electric soldering
other soldering equipment. *Ins*
& Wires, Inc.

278. Specification Key
Guide to Government specific
for phosphatizing, rust-proofin
paint bonding chemicals. *Am*
Chemical Paint

279. Springs
12-page booklet on inspectio
quality control of springs. *I*
Spring Co.

280. Stainless Castings
Technical data chart gives de
tions, composition, mechanical &
ical properties. *Cooper Alloy F*

281. Stainless Fastenings
20-page catalog of stainless st
screws, nuts, washers, machine
sheet metal screws, set screws, pi
ting and specialties. *Star St*
Screw

282. Stainless Steel
12-page booklet on stainless
products for chemical and pet
industries. *Solar Aircraft*

283. Stainless Steel
Bulletin shows plates, forgings,
tank heads, flanges. *G. O. Carls*

284. Stainless Steel
44-page book gives detailed in
tion on use of stainless steel
chemical industries. *Crucible St*

285. Stainless Steel
16-page "Type 430 Stainless f
chitects & Designers". *Washingto*

286. Steel Plate
32-page catalog 1243 on steel pl
carburizing, heat treating and w
Many uses illustrated. *W. J. Hol*

287. Steel Plate
Slide chart gives plate weig
various widths, thicknesses. *Lu*

288. Strain Indicator
Bulletin 4103 on SR-4 Model M
able strain indicator. *Baldwin*
Hamilton

289. Stress Relief of Tita
April "Review" gives data on
temperature combinations for st
lief of titanium. *Rem-Cru*

FIRST
PERMIT
(Sec. 34.9
Clevela

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed In the United States

4c POSTAGE WILL BE PAID BY—

METAL PROGRESS
7301 Euclid Avenue
CLEVELAND 3, OHIO

ze
nze from "Lavin-
". *Lavin*

ore solder. Wire
d quantities. *Fed-*

ons
soldering irons,
ment. *Insulation*

Key
ent specifications
ust-proofing and
icals. *American*

inspection and
springs. *Hunter*

stings
rt gives designa-
echanical & phys-
er Alloy Foundry

stenings
stainless steel cap
machine screws,
t screws, pipe fit-
Star Stainless

eel
n stainless alloy
al and petroleum
craft

eel
s, forgings, sheets,
G. O. Carlson

eel
detailed informa-
less steel in the
Crucible Steel

eel
Stainless for Ar-
Washington Steel

3 on steel plate for
ating and welding.
. *W. J. Holliday*

plate weights for
nesses. *Lukens*

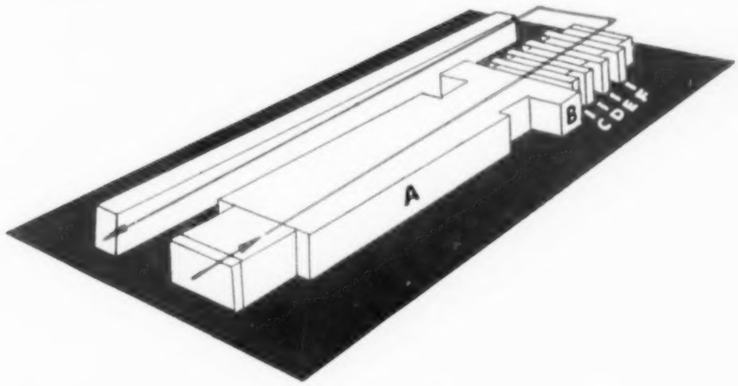
rator
R-4 Model M port-
. *Baldwin-Lima-*

f of Titanium
ves data on time-
tions for stress re-
n-Cru

FIRST CLASS
PERMIT No. 1595
(Sec. 34.9 P. L. & R.)
Cleveland, Ohio

Heat Treat Furnace Layout

by Holcroft... 2nd of a Series



- **A** Annealing furnace
- **B** Hot salt quench
- **C** Wash
- **D** Acid bath
- **E** Wash
- **F** Oil dip

Volume Production Castings
Annealed, Descaled, Desanded

This "U-type" furnace layout by Holcroft ties right into the production line of a large automotive plant.

The unit anneals, descales and desands 10,000 pounds of castings each hour. After annealing, the stock is dipped in a salt quench, rinsed in water, bathed in acid, water-washed again, and dipped into a soluble oil to prevent rust. A return conveyor automatically brings the trays back to the loading point.

Unusual layouts like this present no particular problem for Holcroft. After all, it's an inherent part of the job to be completely responsible for the work—from the time it is to be heat treated to the time it's ready for finishing operations. It's the type of work Holcroft does well. Holcroft & Company, 6545 Epworth, Detroit 10, Michigan.

BUILT BY HOLCROFT & COMPANY DETROIT MICH.

PRODUCTION HEAT TREAT FURNACES FOR EVERY PURPOSE

CHICAGO 9	CLEVELAND 15	HOUSTON 1	CANADA	EUROPE
J. H. Bradley, A. A. Engelhardt	Wallace F. Schott	R. E. McArdle	Walker Metal Products, Ltd	S. O. F. I. M.
4209 South Western Blvd.	1900 Euclid Ave.	5724 Navigation Blvd.	Windsor, Ontario	Paris 8, France

290. Subzero Freezer
8-page folder on portable freezer, 110-volt a.c., operating to −180 F., for shrink fitting, hardening, stabilizing and testing. *Webber Appliance*

291. Sulphur Determination
Literature on 3-min. determinator for use with combustion furnace. *Dietert*

292. Superalloy Fasteners
"Bolt News" article tells how new superalloys are being made into fasteners for jet engines, guided missiles and atomic propulsion uses. *H. M. Harper*

293. Surface Pyrometer
Bulletin 168 on instrument for quick, accurate readings of surface temperatures. *Pyrometer Instrument*

294. Surface Roughness
8-page bulletin on basic features and applications of direct reading shop profilometer. *Micrometrical Mfg. Co.*

295. Television, Industrial
Folder on equipment and uses of television in industry. *RCA*

296. Television, Industrial
Reprint includes applications to melting and heating furnaces. *Diamond Power Specialty*

297. Temperature Control
Catalog of pyrometer supplies gives data on thermocouples, protection tubes, other accessories. *Arklay S. Richards*

298. Test Chambers
Catalog folder on environmental test chambers for temperature, humidity, altitude and various combinations including extremely low temperature. *American Research Corp.*

299. Testing
Bulletin 47 on Super L universal testing machines. *Tinius Olsen*

300. Testing Machines
28-page catalog on screw power universal testing machines and accessories. Construction, specifications. *Riehle*

301. Testing Machines
8-page folder on Amsler machines for tests in tension, compression, torsion, shear, fatigue, bending and ductility. *A. I. Buehler*

302. Textured Stainless
Folder on stainless to conserve alloys and reduce weight. *Rigidized Metals*

303. Thermobalance
Bulletin on Chevenard thermobalance for continuous weighing of metal specimens during heat treatment or corrosion. *Ferner*

304. Tong Ammeters
Bulletin on tong test ammeters, a.c. or d.c., for instant current measurements without breaking circuit or touching conductor. *Columbia Electric*

305. Tool and Die Steels
26-page book on six oil and air hardening steels for high-production tools and dies. Many uses illustrated. *Bethlehem Steel*

306. End Uses of Zinc Die Castings

48-page book shows 116 applications of zinc die castings in following groups: household

equipment, business machines, hardware, industrial equipment, automotive, tools, communications, toys, photographic, and military. *New Jersey Zinc*

307. Tool Steel
Comprehensive data book on drill rod. *Solar Steel*

308. Transfer Machines
Bulletin on fully automatic transfer machines that combine double-end machining and cutting to accurate length. *Motch & Merryweather Mach.*

309. Transformer Laminations
124-page book gives technical data and drawings of all available standard shapes. *Allegheny Ludlum*

310. Treating Torsion Bars
Article describes automatic furnace for heat treating torsion bars. *Sunbeam*

311. Tube Straightening
Catalog describes two-roll rotary straightener for round tubes and bars $\frac{1}{16}$ to [illegible] in. O.D. *Medart Co.*

312. Tubing
52-page "Handbook of Seamless Steel Tubing". 26 pages of data. *Timken*

313. Tubing
Catalog No. 20 describes complete line of small tubing, giving analyses and sizes. *Superior Tube*

314. Tubing Failures
10-page reprint on heating tube failures. *Babcock & Wilcox*

315. Tungsten Electrodes
Wall chart gives data for inert-gas arc-welding of aluminum, magnesium, stainless steel with pure and thoriated tungsten electrodes. *Sylvania*

316. Ultrasonic Inspection
Set of application sheets, each describing a specific use for ultrasonic inspection. *Sperry Products*

317. Universal Machine
Bulletin 118 on machine for turning, grinding, milling, drilling and other operations. *Newage*

318. Welding Magnesium
Article on inert-gas-shielded metal-arc welding of magnesium includes numerous illustrations and tables of data. *Dow Chemical*

319. Welding Pressure Vessels
Reprint describes procedures for welding stainless, stainless-clad and copper alloy pressure vessels and refinery components. *Air Reduction*

320. Welding Stainless
8-page Bulletin GET-1955 gives arc-welding practices for stainless steels. *General Electric*

321. Welding Stainless
12-page bulletin on arc welding electrodes for stainless steel. *Metal & Thermit*

322. Wire Baskets
84-page book on fabricated baskets for dipping and heat treating. *Cambridge Wire Cloth*

323. Zinc and Cadmium Plate
Technical data sheets on use of Luster-on salts for zinc and cadmium plating. *Chemical Corp.*

324. Zirconium
26-page booklet gives physical, mechanical and chemical properties, present and potential uses, supply and prices of zirconium. *Zirconium Metals*

July, 1953

1	26	51	76	101	126	151	176	201	226	251	276	301
2	27	52	77	102	127	152	177	202	227	252	277	302
3	28	53	78	103	128	153	178	203	228	253	278	303
4	29	54	79	104	129	154	179	204	229	254	279	304
5	30	55	80	105	130	155	180	205	230	255	280	305
6	31	56	81	106	131	156	181	206	231	256	281	306
7	32	57	82	107	132	157	182	207	232	257	282	307
8	33	58	83	108	133	158	183	208	233	258	283	308
9	34	59	84	109	134	159	184	209	234	259	284	309
10	35	60	85	110	135	160	185	210	235	260	285	310
11	36	61	86	111	136	161	186	211	236	261	286	311
12	37	62	87	112	137	162	187	212	237	262	287	312
13	38	63	88	113	138	163	188	213	238	263	288	313
14	39	64	89	114	139	164	189	214	239	264	289	314
15	40	65	90	115	140	165	190	215	240	265	290	315
16	41	66	91	116	141	166	191	216	241	266	291	316
17	42	67	92	117	142	167	192	217	242	267	292	317
18	43	68	93	118	143	168	193	218	243	268	293	318
19	44	69	94	119	144	169	194	219	244	269	294	319
20	45	70	95	120	145	170	195	220	245	270	295	320
21	46	71	96	121	146	171	196	221	246	271	296	321
22	47	72	97	122	147	172	197	222	247	272	297	322
23	48	73	98	123	148	173	198	223	248	273	298	323
24	49	74	99	124	149	174	199	224	249	274	299	324
25	50	75	100	125	150	175	200	225	250	275	300	

METAL PROGRESS

7301 Euclid Avenue, Cleveland 3, Ohio

Please have literature circled at the left sent to me.

Name ______

Title ______

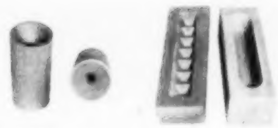
Company ______

Address ______

City and State ______

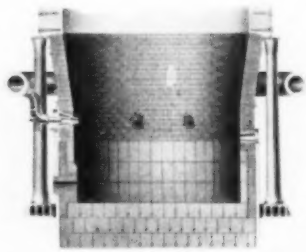
Postcard must be mailed prior to October 1, 1953—
Students should write direct to manufacturers.

GRAPHITE CRUCIBLES



GRAPHITE MOLDS

GRAPHITE SINTERING BOATS & TRAYS



CARBON BLAST FURNACE LININGS

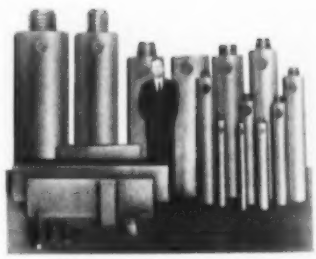
GET MORE TONNAGE FOR LESS

WITH THESE

NATIONAL

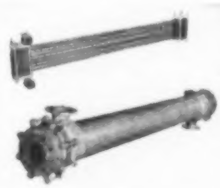
TRADE-MARK

Carbon and Graphite Products

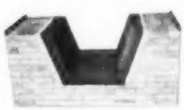


CARBON & GRAPHITE ELECTRIC FURNACE ELECTRODES

GRAPHITE FLUXING TUBES



"KARBATE" IMPERVIOUS GRAPHITE HEAT EXCHANGERS



CARBON LININGS FOR RUN-OUT TROUGHS

"KARBATE" IMPERVIOUS GRAPHITE PLATE HEATERS AND CARBON TANK LININGS

NO OTHER MATERIAL PROVIDES THIS COMBINATION OF PROPERTIES!

- Chemically inert
- Does not melt
- Low coefficient of thermal expansion
- Good thermal conductivity
- Excellent electrical conductivity
- Non-contaminating
- Resists wetting by molten metal and dross

CARBON CINDER NOTCH LINERS

CARBON LININGS FOR CUPOLAS AND TROUGHS

The terms "National" and "Karbate" are registered trade-marks of Union Carbide and Carbon Corporation

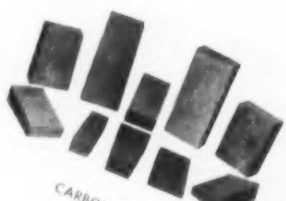
NATIONAL CARBON COMPANY

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

IN CANADA:
National Carbon Limited, Montreal, Toronto, Winnipeg



CARBON BRICK

SOME OTHER NATIONAL PRODUCTS

CARBON LININGS FOR FERRO-ALLOY FURNACES • CARBON MOLD PLUGS • GRAPHITE THERMOCOUPLE SHEATHS • GRAPHITE STARTERS FOR HOT-TOPPING • CARBON CINDER NOTCH PLUGS • GRAPHITE AND CARBON CORES • GRAPHITE RISER RODS • CARBON BOXES AND GRAPHITE POWDERS FOR HEAT-TREATING • PIPE AND FITTINGS • CARBON BRICK • PUMPS • CONDUCTOR ROLLS • SPECTROSCOPIC ELECTRODES • STEAM JETS • ANODES

The New Louisiana Purchase

EVERY day America crosses a frontier—the frontier of a new market. It is the market created by an ever growing population. Since Pearl Harbor, our population has increased 23½ millions—more than all the people now living in the region west of the Mississippi once called the Louisiana purchase, that vast billion-acre area which provided us with geographical frontiers for a hundred years.

During 1952, 8,500 babies were born daily, increasing our population by nearly 3,000,000 people. New families and bigger families need more and bigger houses, more food, clothing, cars, roads, hospitals, churches, schools. Their needs call for continuing and increasing production from farms and factories.

There are those among us who say a decline in government spending will bring depression. But where is there room for depression when we add the population of another Minnesota or an Iowa to our nation each year—when the need for goods and services increases steadily? In fact, only by tapering off our vast programs of government spending can industry and business hope to provide sufficient goods to maintain our present standard of living and satisfy the demands of our ever growing population.

Let no one tell you America has crossed its last frontier.

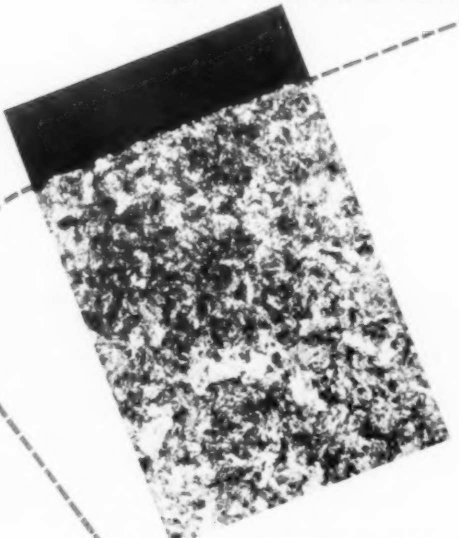
QUALITY YOUNGSTOWN SERVICE

The Youngstown Sheet and Tube Company

General Offices--Youngstown 1, Ohio
Export Offices--500 Fifth Avenue, New York
MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

RAILROAD TRACK SPIKES - CONDUIT - HOT AND COLD FINISHED CARBON AND ALLOY BARS - PIPE AND TUBULAR PRODUCTS - WIRE - ELECTROLYTIC TIN PLATE - COKE TIN PLATE - RODS - SHEETS - PLATES.

SCALE FREE—DECARB FREE Hardening for ALL Engineering Steels



Photomicrograph showing absence of scale or decarburization in a section of S.A.E. 1085 steel (X100) neutral salt bath hardened at 1500°F. and quenched in oil. (Etched in 2% Nital.)

By its very nature the Ajax Electric Salt Bath Furnace guards against pitting, scaling, carburizing or decarburizing in the hardening of carbon, alloy, stainless and high carbon-high chromium steels in the temperature range from 1450° F. to 1950° F. The liquid neutral salt bath not only prevents these surface effects by sealing the work from air during heating, but leaves a protective film of salt on it right up to the moment of quenching. All need for "protective atmospheres," gas generating equipment and specially trained operators is eliminated.

Heating cycles are from 4 to 6 times faster than in atmosphere or radiant type furnaces, thus enabling small, relatively inexpensive salt bath equipment to handle an amazing volume of work. Heat is transferred by conduction rather than by convection or radiation, all surfaces of the work being in direct contact with the molten salt. Heating is extremely rapid and uniform. Distortion is reduced to a negligible minimum.

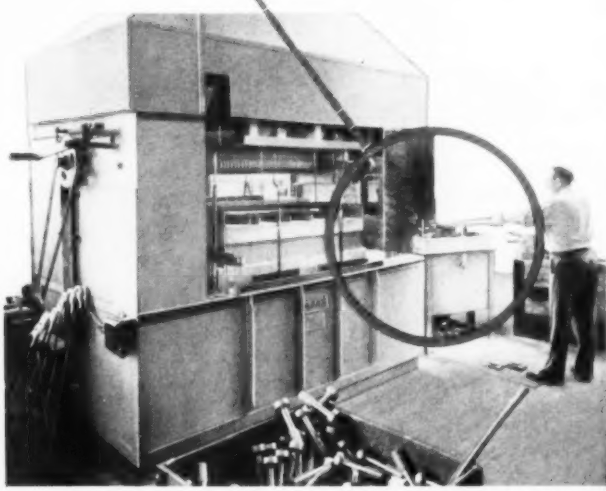
The unique internal heating principle of the Ajax furnace produces an automatic electrodynamic stirring action which contributes to rapid heating and assures a temperature variation of *less than* 5° F. throughout the bath.

Ajax furnaces assure low operating and maintenance costs and no skilled labor is required. Ceramic pots last 5 years or longer (many are still in use after 8 years continuous service).

AJAX ELECTRIC COMPANY, Inc.

WORLD'S LARGEST MANUFACTURER OF ELECTRIC HEAT TREATING FURNACES EXCLUSIVELY

910 Frankford Ave. Philadelphia 23, Pa.



Automotive spline shafts being heated in a neutral salt bath equipped with a screw-conveyor mechanism. Temperature of the work is held within 5°F. even in this relatively large bath —6 ft. long, 2 ft. wide and 2 ft. deep.

SEE FOR YOURSELF!

Send or bring a sample batch of your work for salt bath hardening under actual shop conditions in the Ajax Metallurgical Service Laboratory. There is not the slightest obligation.

AJAX HULTGREN ELECTRIC SALT BATH FURNACES

10

To help you...
available without charge . . .

Important Technical Handbooks

Put Reynolds Technical Knowledge To Work for You . . . If you are part of a plant management, design or production group, you'll find these interesting, helpful books of real value. Each deals with an important phase of aluminum design and fabrication. Each is fully illustrated and comprehensively discusses all aspects of its subject. These authoritative handbooks by the technical experts on aluminum at Reynolds belong on your desk for ready reference. And, to put added interest in your training programs and technical society meetings, you'll want to use Reynolds 16mm. sound-color-films on aluminum. Please request handbooks or films on your business letterhead.

Also see our condensed catalog $\frac{1a}{Rey}$ in Sweet's Product Design File or write for your personal copy.

Valuable 16MM Color-Sound Films, Too

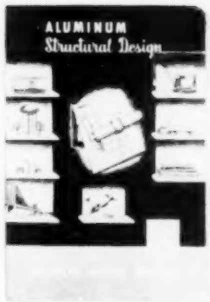
- **SHAPE OF THINGS TO COME.** Interesting description of the aluminum extrusion process and the design opportunities it provides. Running time 30 minutes.
- **TALE OF THE POWDERED PIG.** Developments in aluminum powders and pastes including their application in protective and decorative coatings. Running time 22 minutes.
- **PIGS AND PROGRESS.** The complete story of aluminum from mine to finished products. Covers all forms of aluminum. Running time 26 minutes.

Complete index of Reynolds literature and films on aluminum design and fabrication also available.

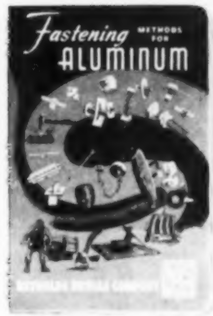
Order from REYNOLDS METALS COMPANY
2519 South Third Street, Louisville 1, Kentucky

Instructors in technical schools are also invited to take advantage of these educational aids.

DESIGNING WITH ALUMINUM EXTRUSIONS—Explains the basic principles for using extruded aluminum shapes most effectively.



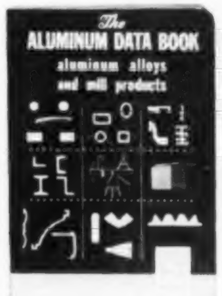
ALUMINUM STRUCTURAL DESIGN—Shows how to design original structures with aluminum or convert present designs to aluminum.



FASTENING METHODS FOR ALUMINUM—Offers information on mechanical joining and fastening methods, and the advantages of each.

FINISHES FOR ALUMINUM—Supplies basic information on the application and uses for electroplated, mechanical, chemical and organic finishes.

on Aluminum Design and Fabrication



ALUMINUM DATA BOOK—Discusses the physical, chemical and metallurgical factors of aluminum as they affect design and fabrication.

ALUMINUM POWDERS AND PASTES—Describes types of powders and their uses in coatings, pyrotechnics, processing, metallurgy, etc.

ALUMINUM FORMING—Describes accepted practices for bending, forming, and drawing aluminum.

MACHINING ALUMINUM ALLOYS—Discusses all phases of aluminum machining including automatic screw machining.

HEAT TREATING ALUMINUM ALLOYS—Explains the methods and results of heat treating suitable aluminum alloys.

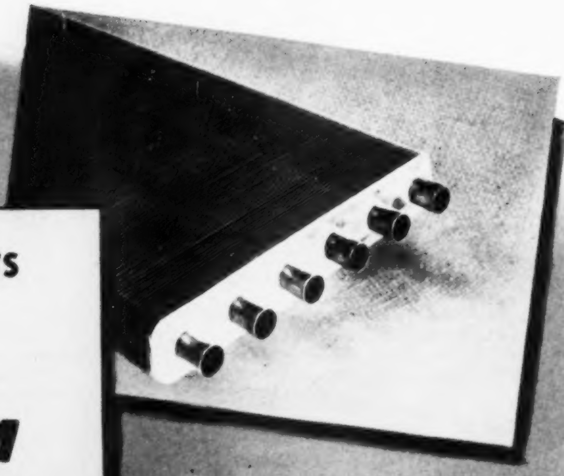
WELDING ALUMINUM—Gives complete information on *all* types of welding as applied to aluminum.

REYNOLDS ALUMINUM

MODERN DESIGN HAS ALUMINUM IN MIND

Cut Production Costs with

REVERE ALUMINUM



Fin stock, made of Revere Aluminum Coiled Sheet, is saving time and money for leading manufacturers of convectors, baseboard convectors, unit heaters, air conditioners and refrigeration equipment—much of it in combination with Revere Copper Tube. Uniformity of properties and accuracy of gage are among the reasons for the widespread use of this fine Revere material.

Available in a number of alloys, Revere Aluminum Products include coiled sheet, extruded products, seamless tube, and forgings, as well as electrical bar. The Revere Technical Advisory Service is ready to help you use them to advantage.

Send for your free copy of the new 28-page booklet, "Revere Aluminum Extruded Products." Address Dept. ML7.

REVERE ALUMINUM

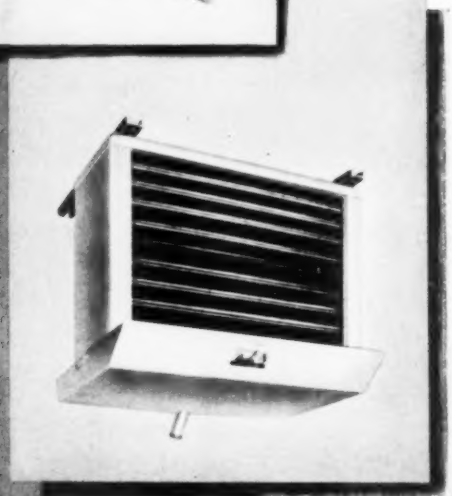
REVERE COPPER AND BRASS INCORPORATED

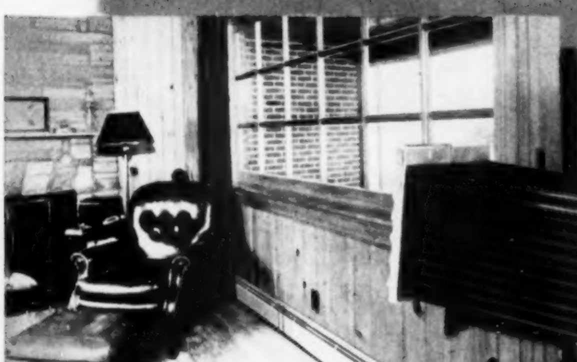
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, N.Y.

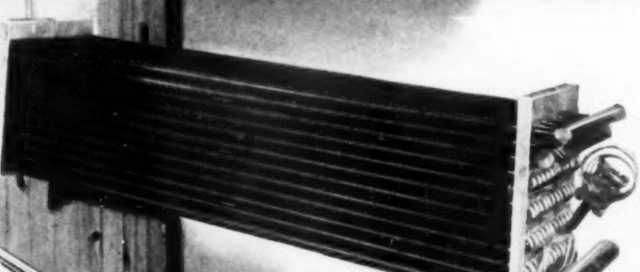
• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities.

SEE REVERE'S "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY







FEI Furnaces... THE ALL-IN-ONE BUY for GALVANIZING

Kettle Life More Than Tripled with F.E.I. *Patented Settings*

Out of Furnace Engineers' more than 30 years experience has come the ALL-IN-ONE BUY for galvanizing that sets new records for high production at low cost.

UNIQUE DESIGN... NO STACK REQUIRED. In a typical Pipe Galvanizing plant, kettle life was increased from 20,000 to 70,000 tons, thanks to F.E.I. patented baffle type burners and eductor, requiring no costly stack.

AUTOMATIC CONTROL... FLEXIBILITY. F.E.I. *fully automatic control* insures uniform temperature, flexible high and idling operation, minimum fuel consumption, increased output. Loss from shut-downs, formerly a major item, is now negligible. F.E.I. service is complete—from original analysis of your needs through to actual production.

SHEETS · TUBES · METALWARE

WRITE FOR THIS BULLETIN
It tells how F. E. I. technique has made ordinary methods obsolete.

Top photo: F. E. I. equipment for galvanizing sheets.

Lower photo: F. E. I. installation for galvanizing metalware.

FEI FURNACE ENGINEERS, INC.

Affiliated with BRASSERT CORPORATION, NILES CONSTRUCTION CO. and STANDARD BOILER & PLATE IRON CO.

General Offices: 210 BOULEVARD OF THE ALLIES, PITTSBURGH, PA.

ROLOCK

FABRICATED ALLOYS

HEAT AND CORROSION RESISTANT

LEFT: Parts entering roller hearth furnace on "Serpentine" trays.
BELOW: "Serpentine" trays on loading table.

"SERPENTINE" DESIGN *minimizes*

WARPAGE . . . LOWERS HOUR-COSTS for FURNACE TRAYS

. . . *at* PRATT & WHITNEY AIRCRAFT

Rolock "Serpentine" furnace trays are carrying jet engine parts through a Westinghouse roller hearth furnace with an Exothermic atmosphere at maximum temperature of 2050°F.

Rolock quoted on another type of tray as well as the "Serpentine," but 100 "Serpentine" trays were purchased for original equipment and have so far had many months of continuous use . . . with additional orders placed during that time.

The exclusive Rolock Serpentine construction gives freedom to expansion and contraction in both directions, minimizing warping to a greater degree than any other furnace tray Rolock has seen. It is available to order in any practical length, width and depth . . . as a tray or as the base of a basket or crate.

Rolock engineers invite your requests for solution of specific metal treating problems. Our experience covers hundreds of nationally known industrial plants.

HEAT TREATING . . . OR CORROSION RESISTANT CATALOGS ON REQUEST.

Offices in: PHILADELPHIA, CLEVELAND, DETROIT, HOUSTON, CHICAGO, ST. LOUIS, LOS ANGELES, MINNEAPOLIS, PITTSBURGH

ROLOCK INC. · 1222 KINGS HIGHWAY, FAIRFIELD, CONN.

JOB-ENGINEERED for better work
Easier Operation, Lower Cost

Ceramic Coating of Jet Engine Parts

another of the precision-processing operations with *the Productive Flames of* GAS

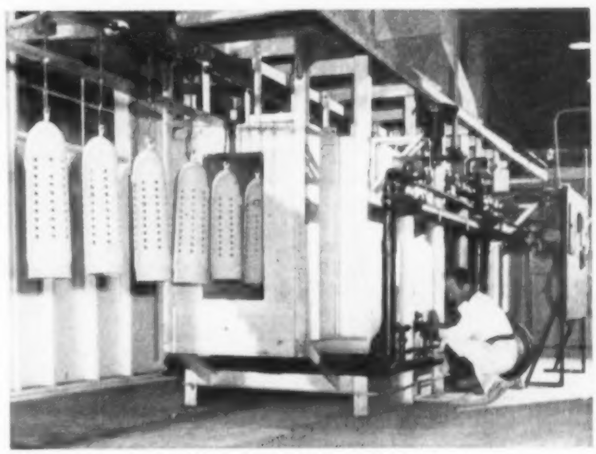
at SOLAR AIRCRAFT CO., San Diego, California

Solaramic, a new family of ceramic coatings, is used in Solar Aircraft Company's Solaramic pilot plant. The highly refractory materials used to make Solaramic frits are fused in a Gas furnace which maintains carefully controlled temperature to 2500 F.

Applied to jet engine parts, this new coating protects pieces against corrosion and oxidation, instead of acting only as an insulating medium. In addition, this GAS-fired ceramic coating:

★ Reduces hot spots on parts
★ Minimizes cracking and warping
★ Increases fatigue life
★ Improves gall resistance under high-temperature conditions

Parts are sprayed with Solaramic and placed in a GAS-fired semi-muffle oven furnace where the temperature is precisely and automatically controlled. Firing temperatures range between 1700 and 2000 F., assuring dependable adherence of the coating to the metal.



Continuous GAS-fired Furnace in use in conveyorized production line for Solaramic Jet parts.

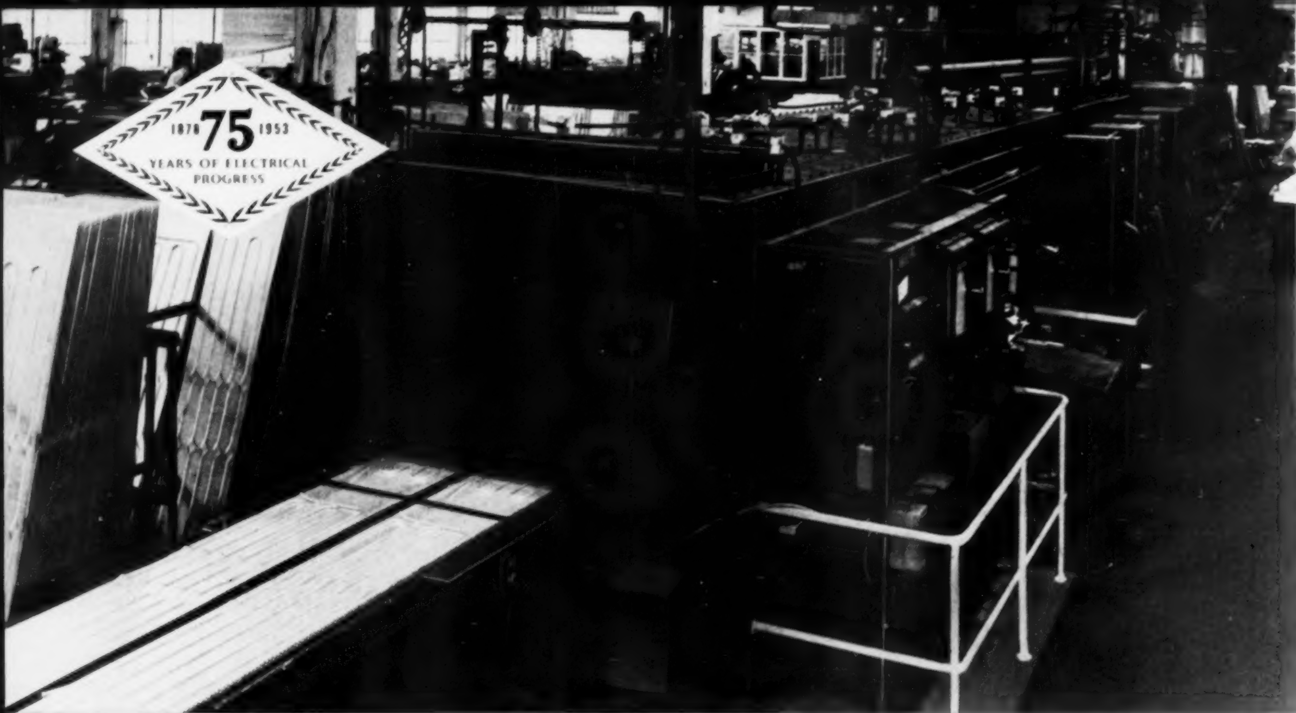
The Productive Flames of GAS are utilized in this industrial process because GAS:

1. Allows rapid temperature recovery after charging
2. Permits exact control of temperatures, *automatically*
3. Permits easy adjustment of furnace atmosphere as required

GAS is the modern fuel for all industry, because GAS is versatile in application, clean, and can be automatically controlled to provide exact temperatures required. Modern Industrial Gas Equipment fits production-line techniques. For the facts, see your Gas Company Representative.

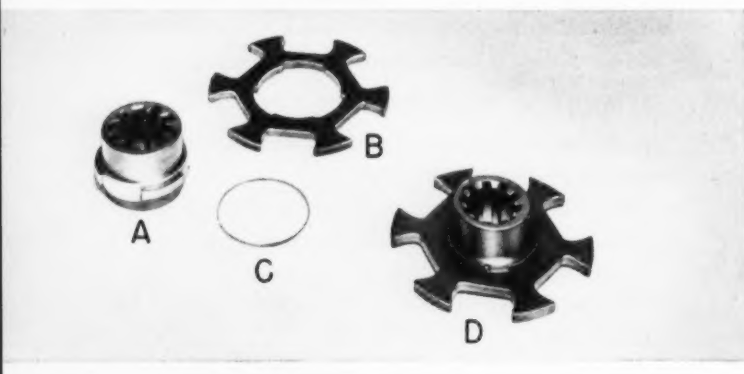
MORE AND MORE THE TREND IS TO GAS FOR ALL INDUSTRIAL HEATING

AMERICAN GAS ASSOCIATION
420 LEXINGTON AVENUE • NEW YORK 17, N.Y.

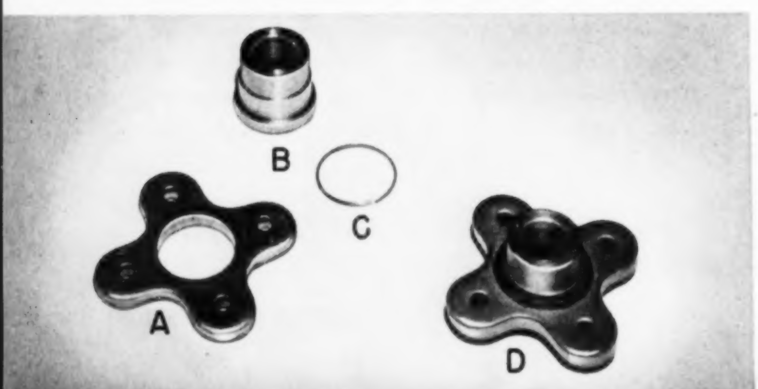


1 **FURNACE BRAZING ALUMINUM ALLOYS** offers you many advantages: (1) cost is lower than either gas or arc welding, (2) brazed parts have a neater finish, (3) furnace brazing is easily adaptable to production line methods, and (4) sections too thin for welding can be brazed successfully. An increasing number of aluminum assemblies such as the refrigerator evaporators above are being fabricated by furnace brazing.

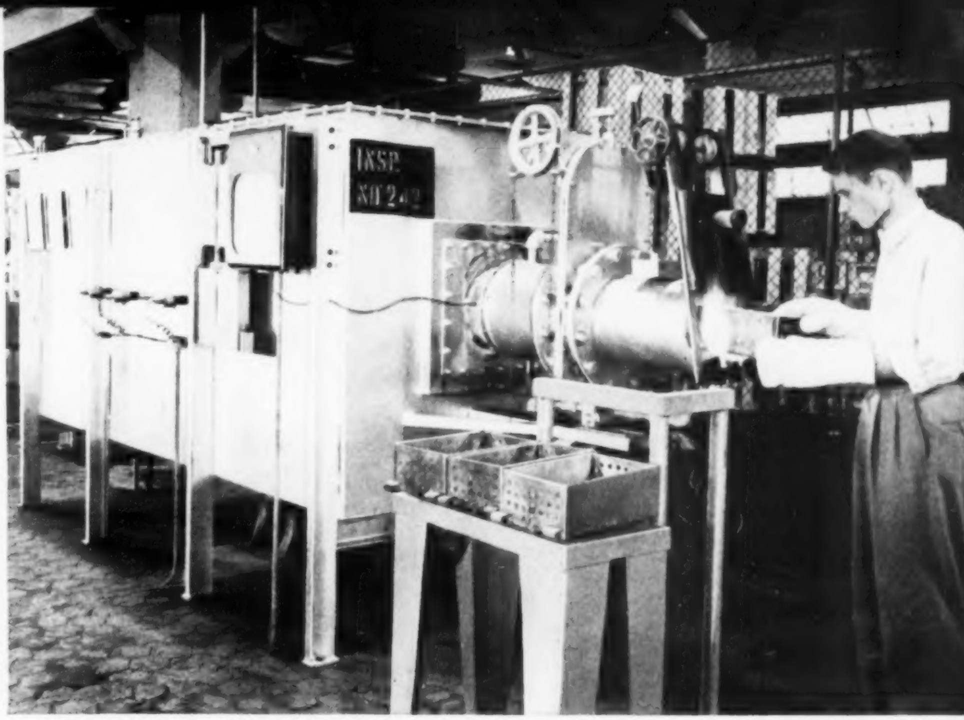
Five Brazing Applications



3 **SAVINGS OF 15 CENTS EACH** are reported on the fabrication of this clutch hub by furnace brazing. When formerly forged the assembly required expensive machining on the flange. For furnace brazing the operations are simple. The splined hub A is assembled with the punched flange B made from black hot-rolled steel, with the copper ring C placed at the joint. The hole in the flange is simply punched, with no reaming or broaching operation necessary. Serviceability of the furnace-brazed assembly is reported to be excellent.



4 **SAVINGS OF 66% IN MATERIAL** and $2\frac{1}{2}$ cents on each pulley are the result of fabricating this assembly by furnace brazing. When formerly forged the part was cut from a section of bar stock about $2\frac{3}{4}$ in. in diameter and weighing about $1\frac{1}{2}$ lbs. Now, in furnace brazing, parts made from blanks weighing only $\frac{1}{2}$ lb are used. The process is accomplished by brazing punching A to screw machine part B with copper ring C to form assembly D.



2 BRIGHT BRAZING STAINLESS STEEL without flux in this semi-continuous furnace eliminates the characteristic green chromium-oxide and flux deposit. Because parts come out bright and shiny, no cleaning operations are necessary. Stainless assemblies such as the jet engine parts shown at left before and after brazing are brazed in protective atmospheres of pure dry hydrogen or dissociated ammonia in metal retorts.

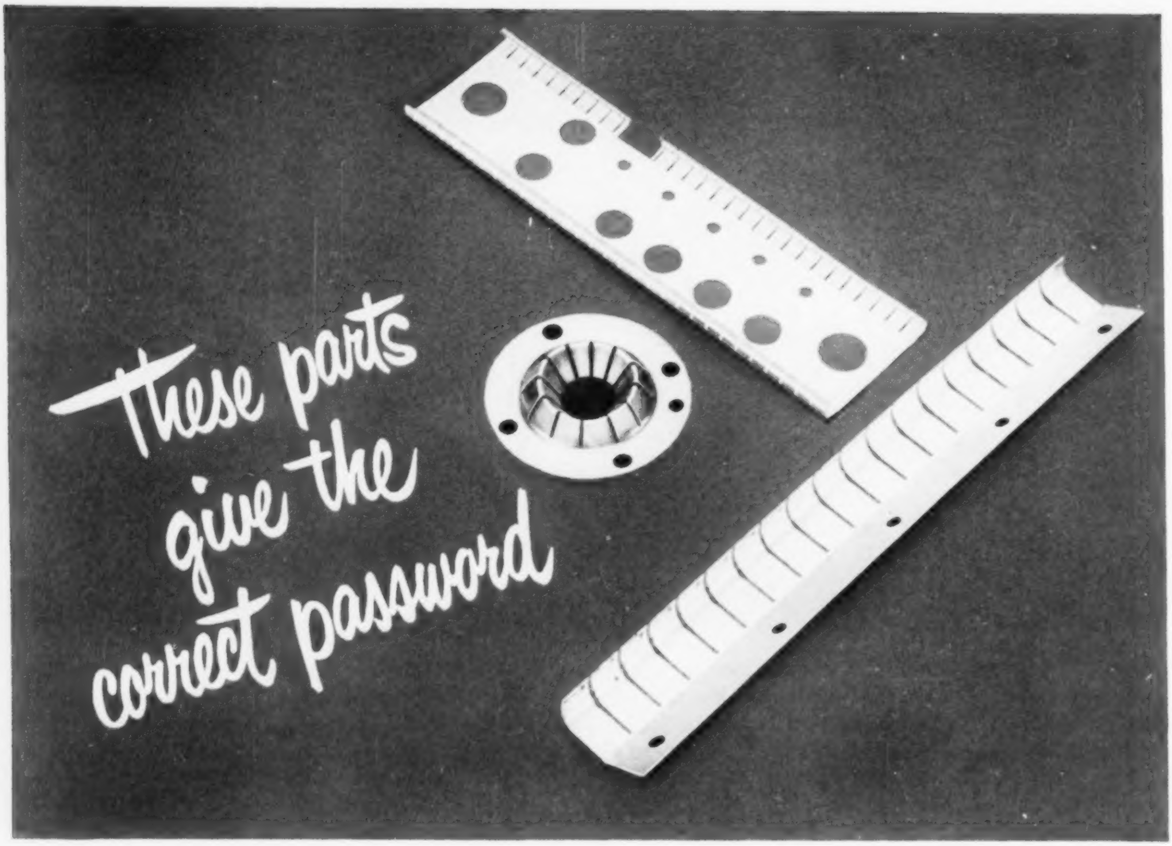
That Can Save You Money

5 INDUCTION HEAT FOR SILVER BRAZING stainless steel helps this user increase production 50%, reduce rejects, eliminate leakers, and get uniformly stronger joints. Here, an operator brazes two stainless-steel nipples at a time into the stainless-steel head of a heater tank. Savings of 25% in silver solder are made possible with induction heat. Formerly, hand torches were used to perform this operation with non-uniform results and considerably more rejects.

For more information on how to apply brazing to your operations, contact the Heating Specialist in your nearest G-E Apparatus Sales Office. His years of experience involving every type of heating installation will be useful to you in solving your heating problems. General Electric Company, Schenectady 5, New York. 720-103

You can put your confidence in—

GENERAL ELECTRIC



Parts shown processed by H. Braun Tool & Instrument Co., Hawthorne, N.J.

THEY'RE MADE OF BERYLCO BERYLLIUM COPPER

If the IFF radar device used by aircraft should give the wrong signal, our own planes would be in danger of being shot down by antiaircraft and fighter interceptors. Small but vital beryllium copper parts prevent any such catastrophe.

To insure the correct signal, each finger in the circular part must have uniform tension and must line up perfectly. That's one reason why beryllium copper was chosen for this application. The required accuracy can be achieved only by fixture heat treating, and Berylco is the only material that can stand such severe forming and still retain its desirable spring properties.

Of course there are other reasons why this versatile alloy is used here. Its resistance to fatigue, corrosion and relaxation; its electrical conductivity; its indifference to temperature variations—all are important.

The ability of Berylco to offer the designer more than one desirable property has materially increased its application—for peacetime products as well as those used in defense. If you would like to include Berylco in your plans for the future, we invite you to share the knowledge of the world's largest producer of beryllium copper. Call or write any of the offices listed below for help or sample material.

THE MOST COMPLETE LISTING of available beryllium copper forms is contained in the Berylco *Product Directory*, just published. Send for your free copy today.

TOMORROW'S PRODUCTS ARE PLANNED TODAY—WITH BERYLCO BERYLLIUM COPPER

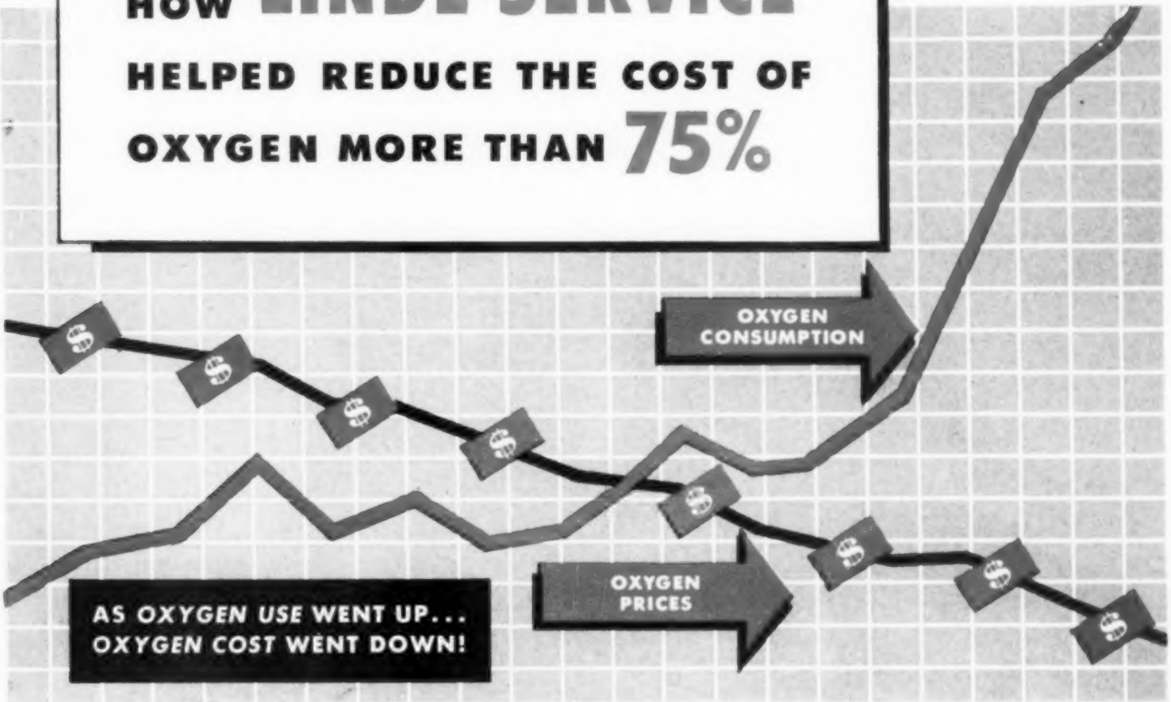
BERYLCO THE BERYLLIUM CORPORATION

DEPT. 3G, READING 9, PENNSYLVANIA

New York • Springfield, Mass. • Rochester, N.Y. • Philadelphia • Cleveland • Dayton • Detroit • Chicago • Minneapolis • Seattle • San Francisco • Los Angeles

Representatives in principal world-trade centers

HOW LINDE SERVICE* HELPED REDUCE THE COST OF OXYGEN MORE THAN 75%



LINDE SERVICE has brought about important improvements in oxygen production, distribution, and methods of use. In profiting by these improvements, LINDE customers have increased their use of oxygen per ingot-ton of steel produced more than 12 times in 25 years. This increased volume of usage in turn enabled LINDE to reduce the cost of oxygen more than 75% in that time.

With LINDE Oxygen you get *all* these important advantages—

- **DEPENDABILITY OF SUPPLY** — No oxygen shortage due to failure of a single plant. Many strategically located plants to meet every demand.
- **FLEXIBILITY OF SUPPLY** — No fixed capacities. You get what you need when you need it ... and pay only for what you use.
- **LOW UTILIZATION COST** — No capital investment ... no costly maintenance.

PLUS ...* LINDE SERVICE—

The unique combination of research, engineering, and over 40 years of accumulated know-how that is helping LINDE customers save money and improve production in their uses of oxygen and oxy-acetylene processes.

If your company uses oxygen, LINDE SERVICE can mean dollar savings to you. Let us tell you more about it.

LINDE AIR PRODUCTS COMPANY

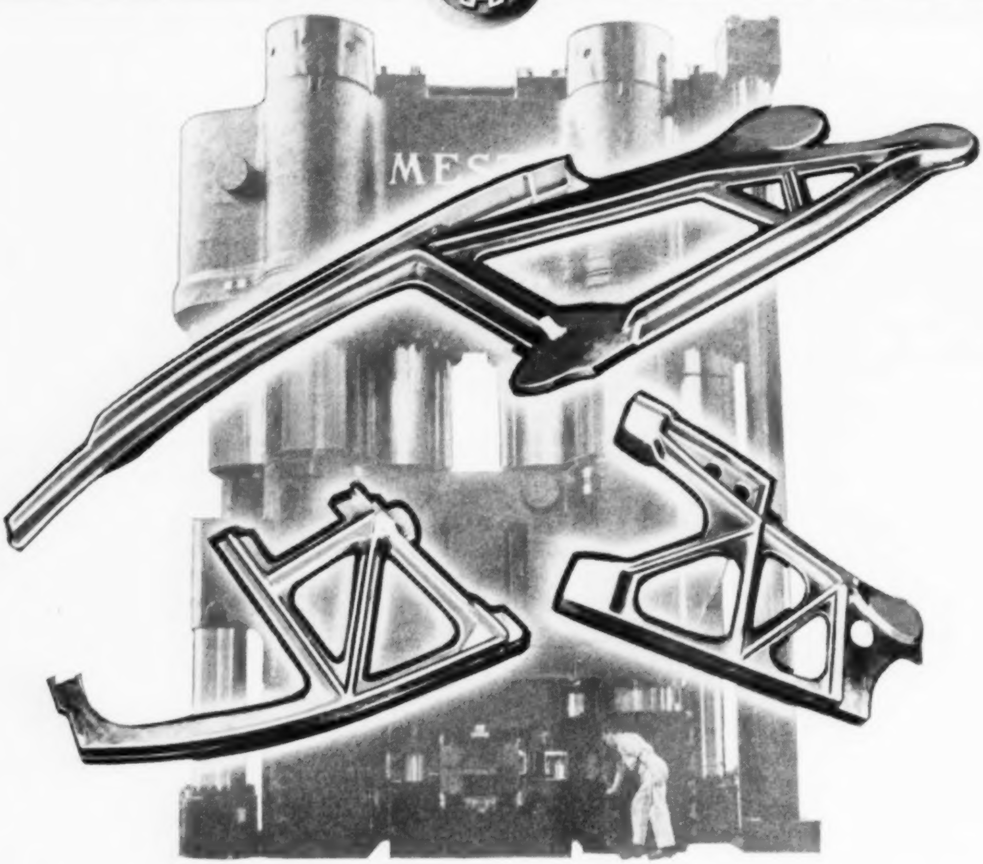
A Division of UNION CARBIDE AND CARBON CORPORATION

30 East 42nd Street UCC New York 17, N. Y.

Offices in Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

Linde
Trade-Mark



Greater Size and Speed in Aircraft have created engineering problems, the solution of which has required larger and larger forgings of high-strength aluminum alloy. *Examples* shown above are forged structural members used in a modern military bomber, the largest more than seven feet over all. These are forged on an 18,000-ton press, the biggest ever built in this country.

Wyman-Gordon Experience—the most extensive in the industry—is keeping abreast of new forging demands involving the use of Steel, Aluminum, Magnesium, High Density Alloys and Titanium.

• • •

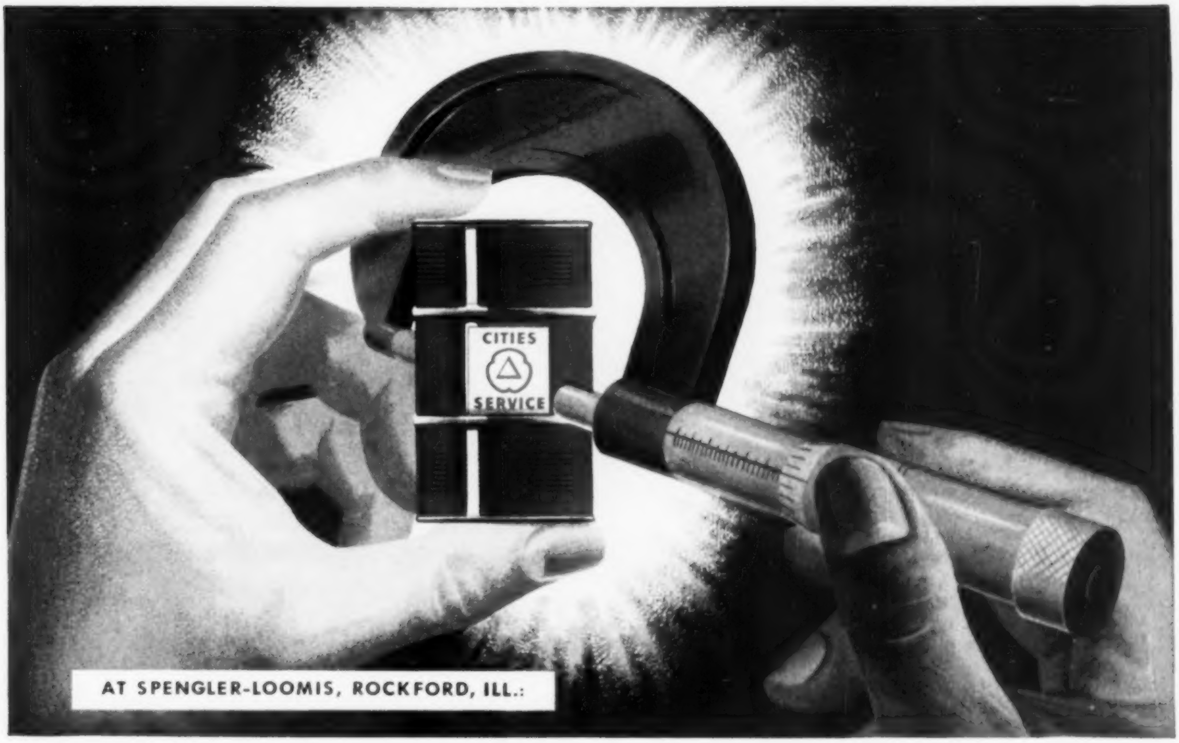
Standard of the Industry for More than Sixty-five Years

WYMAN-GORDON

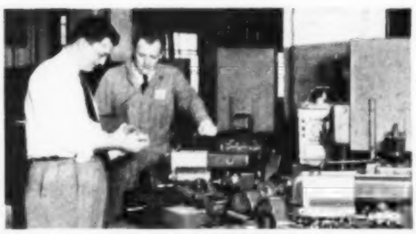
FORGINGS OF ALUMINUM • MAGNESIUM • STEEL

WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS DETROIT, MICHIGAN



Cities Service Cutting Oils Proved The Very Best By Micrometer Test!



CUTTER MEASURED WITH MICROMETER. As a final test, Automatic Pencil Sharpener measures each cutter with a micrometer. All tests proved that Cities Service cutting oil was absolutely tops for this really tough job.

STRICT SPECIFICATIONS REQUIRE FINEST CUTTING OIL. APSCO Sharpeners offer many more features than other brands. To produce their top quality product, Spengler-Loomis relies on top-quality lubrication products . . . Cities Service Products, famous throughout industry.

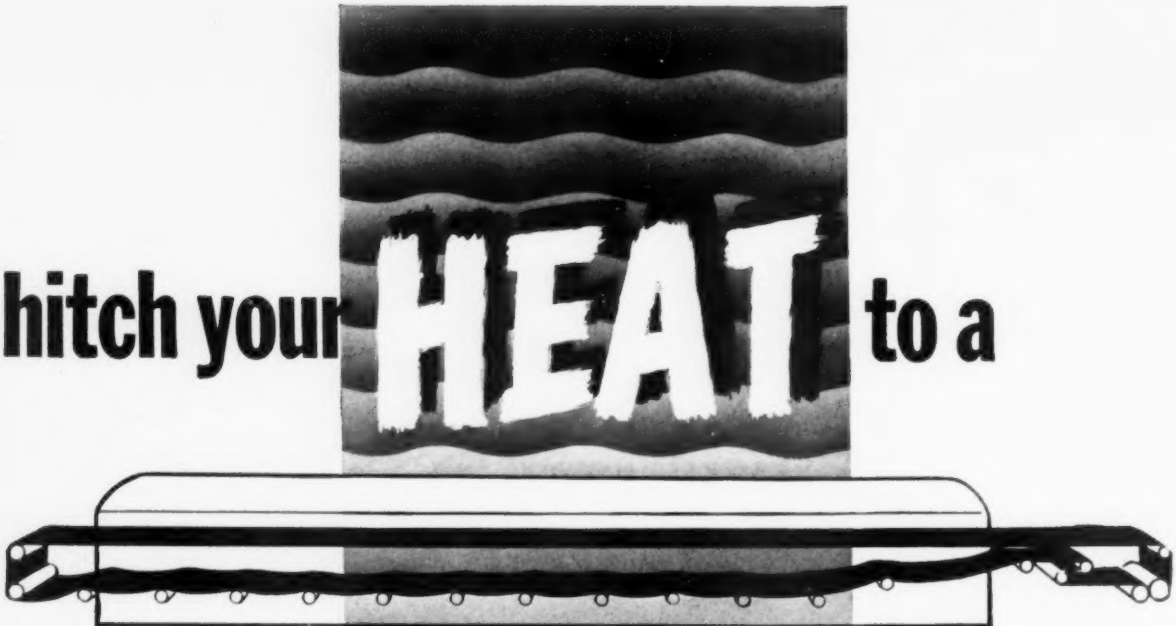
ONLY .005 INCHES BURR OR BUILD-UP ALLOWED IN FIFTY-HOUR OPERATION CUTTING GROOVE IN B1112 STEEL!

Says Mr. C. J. Kostrzewa, Plant Superintendent: "Cutting oil requirements in our Automatic Pencil Sharpener Division are tough. To find the right coolant, we called for, and tested, samples from various companies. Over a period of testing time, we used graphs, charts and tables, keeping a running record on all coolants. As a final test, we measured the cutter with a micrometer before and after milling. The cutting oil that came out tops was Cities Service.

"I'd also like to point out that the Cities Service Engineering staff co-operated fully by offering helpful advice and excellent service."

Why not discuss your lubrication problems with a Cities Service lubrication engineer? Write Cities Service Oil Company, Dept. G14, Sixty Wall Tower, New York 5, New York—or contact your nearest Cities Service office.

CITIES SERVICE
QUALITY PETROLEUM PRODUCTS



hitch your HEAT to a

WISSCO STEEL PROCESSING BELT

■ If your product requires heat processing you can turn it out faster and more economically in continuous-line production with a Wissco Steel Processing Belt.

Wissco Belts give you the advantage of extra durability and heat resistance of chrome nickel alloys...the adaptability and low thermal values of open mesh construction...plus the economy of continuous operation.

To order, write or phone our nearest district sales office.

THE COLORADO FUEL AND IRON CORPORATION—Denver, Colorado
THE CALIFORNIA WIRE CLOTH CORPORATION—Oakland, California
WICKWIRE SPENCER STEEL DIVISION—Atlanta • Boston • Buffalo • Chicago • Detroit • New York • Philadelphia

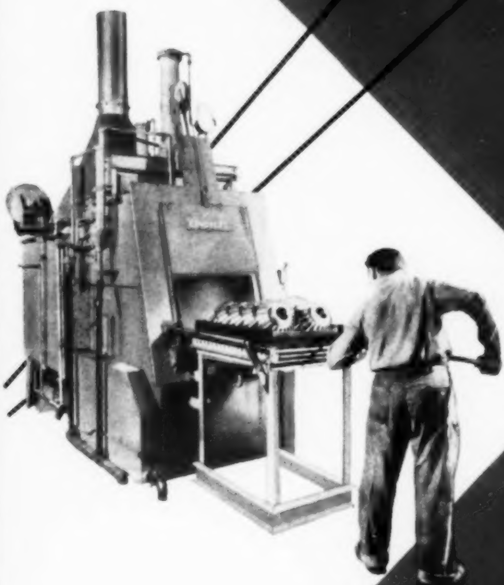
WISSCO BELTS

PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION

CF&I

5 FURNACES IN ONE

the LINDBERG Carbonitriding Furnace



Yes, it's many furnaces in one! It's designed not only for carbonitriding . . but also for hardening, carburizing and carbon restoration. It's self contained . . it's easy to maintain!

10 reasons why Lindberg Carbonitriding Furnaces are better:

1. Heating is by new type, gas-fired, vertical radiant tubes. They weigh only 29 pounds each . . can be changed in two minutes. Just lift out the old one, and lower the new one in its place.
2. Vertical radiant tubes last longer . . often two or three times as long.
3. Quench tank is built-in . . no costly excavation or piping necessary. Distortion is minimized because quenching takes place within furnace structure, and heated work is never exposed to outside air.
4. Quench tank has fin type oil cooler . . maintains oil at proper temperature for quenching.
5. Specially designed purge chamber purges work loads before they enter heating chamber.
6. Special check-light system tells you where charge is at any given time.
7. Control of heating and quenching cycle is automatic. Uniform case depth is assured because each charge remains at heat same length of time.
8. Depending on your production requirements, Lindberg Carbonitriding Furnaces are made for automatic, semi-automatic, or manual charging.
9. You're not experimenting with Lindberg Carbonitriding Furnaces. They've been tested . . under three years of rough operating conditions.
10. The famous Lindberg "Hyen" generators which supply atmosphere for Lindberg Carbonitriding Furnaces are instantly adjustable for many different types of atmospheres.

For full details, ask for bulletin 1241.

LINDBERG FURNACES

Lindberg Engineering Company • 2448 West Hubbard Street • Chicago 21, Illinois

GIANT OF THEM ALL...

for one of America's Largest Presses

MIDVALE PRODUCES 672,000 POUND INGOT FOR NEW AIRCRAFT PRESS

Presses with up to 50,000 ton capacity capable of forming a nearly finished wing section of an airplane—these are the goals of America's planemakers.

First in this program are the huge presses and this giant Midvale ingot is the initial part supplied to the press manufacturer. Cast in Midvale's open hearth furnaces this steel ingot measured 116 inches in diameter and was more than 24 feet high. Midvale craftsmen cast, forged, heat treated and machined this huge part to exact specifications.

Whatever your needs—parts to finished products—Midvale can assure you of precision production. Whether it is roll shells for the mining and cement industries . . . pressure vessels for the chemical and petroleum industries . . . rolls for the paper or steel industry . . . rings for turbines and gears . . . or castings and forgings for any industry . . . Midvale can make them to your most exacting requirements.

Pressure Vessels
Forgings and Rings
Hardened and Ground Steel Rolls
Corrosion and Heat Resisting Castings
Ordnance and Armor

THE MIDVALE COMPANY
NICETOWN, PHILADELPHIA 40, PENNA.
OFFICES: NEW YORK • CHICAGO • PITTSBURGH
WASHINGTON • CLEVELAND • SAN FRANCISCO

MIDVALE
Custom Steel Makers to Industry

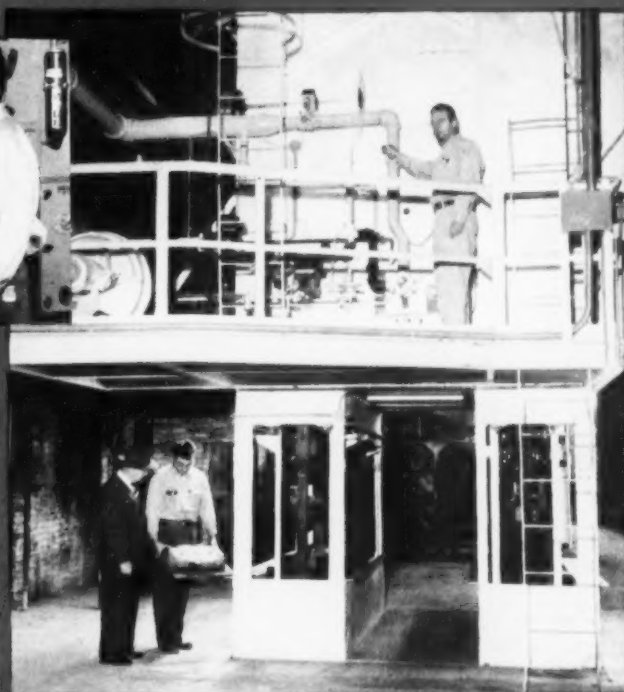
PRODUCERS OF FORGINGS, ROLLS, RINGS, CORROSION AND HEAT RESISTING CASTINGS

BARBER COLMAN

Wheelco Instruments

...control continuous bake in modern foundry TOWER core oven

Wheelco Instruments maintain uniform temperatures in new Tower core oven at Falk Corporation. In this continuous drying operation, cores are placed in a slow-moving elevator conveyer, move up into the oven and 2½ hours later emerge below on the other side. The Wheelco Capacilog Strip Chart Recorder controls and maintains constant record of the oven atmosphere while the Wheelco Panelmount Capacitrol acts as excess temperature limit control. Operator gets continuous, accurate picture and permanent record of operations inside oven. Cores are bone dry at completion of heating cycle. There's no costly overshooting of temperatures. No waste fuel. It pays to modernize with Wheelco Instruments!



All heat changes are permanently recorded on strip chart. Operator sees at a glance exact temperature of oven.

Modern instrument design—Wheelco's "Electronic Link" provides instantaneous control. Measuring system operates without physical contact with recording or controlling mechanism.

Continuous drying oven is 40 feet high. Core is placed on elevator conveyer which carries it into oven for a 2½ hour bake. Dry cores emerge from oven on elevator at opposite side.

Write for bulletin C2-2

Factory-trained field engineers in all principal cities

BARBER-COLMAN COMPANY, ROCKFORD, ILLINOIS

Industrial Instruments • Automatic Controls • Air Distribution Products Aircraft Controls • Small Motors • OVERdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

WHEELCO INSTRUMENTS DIVISION
BARBER-COLMAN COMPANY, DEPT. G, 1518 ROCK ST., ROCKFORD, ILLINOIS

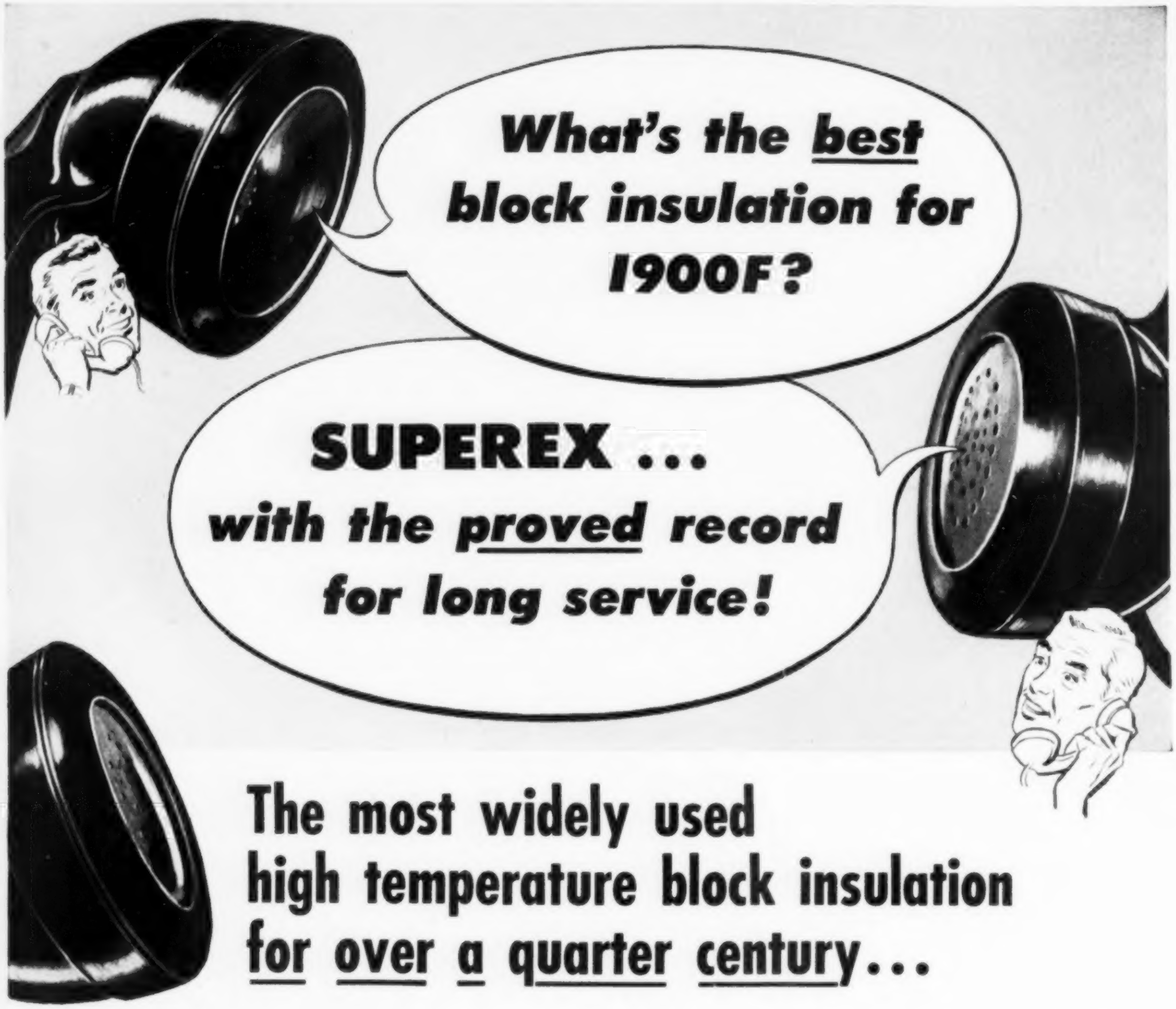
Gentlemen: I'm interested in learning more about Wheelco Instruments for industrial heating. ☐ Please send free bulletin C2-2 ☐ Have field engineer call.

Name ____________________

Firm Name ____________________

Address ____________________

City ____________________ State ____________________



The most widely used high temperature block insulation for over a quarter century...

SUPEREX® high temperature block insulation has long been industry's No. 1 choice for service temperatures up to 1900F. It provides *major* economies . . . reduces fuel costs, cuts heat losses, keeps maintenance expense down, costs less to install and has long service life.

These are the reasons why 90% of the nation's hot blast stoves are Superex insulated . . . and why the low cost open hearth steel producers use Superex in their regenerators.

Made of specially selected and calcined diatomaceous silica blended with other insulating materials and bonded with asbestos fiber, Superex will safely withstand temperatures up to 1900F with negligible shrinkage.

Superex has been used with outstanding success in all types of industrial and metallurgical furnaces and ovens, stationary and marine boilers, auxiliary power plant equipment, regenerators, kilns, roasters, high temperature mains, flues and stacks.

Superex has all these important advantages...

Low thermal conductivity—Exceptionally high heat resistance (1900F) combined with excellent insulating value.

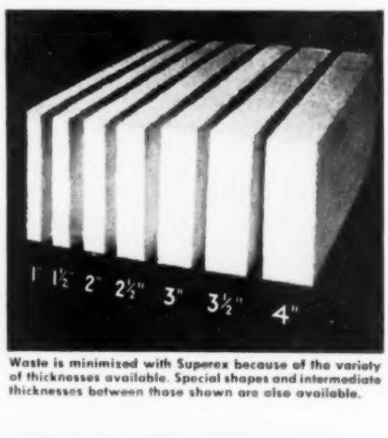
Light weight—Approximately 2 lb per sq ft per in thickness.

Great physical strength—Approximately 6 tons pressure per sq ft are required to compress Superex ½ in.

Long, efficient service life—Superex maintains high insulating value indefinitely—will not disintegrate in the service for which it is recommended.

Fast, easy application—Superex may be cut with an ordinary knife or saw for fitting around openings or to irregular surfaces. Because of its light weight and convenient sizes, Superex assures fast and economical installations.

For complete information about Superex block insulation, write for Brochure IN-134A. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada, write 199 Bay Street, Toronto 1, Ontario.



Waste is minimized with Superex because of the variety of thicknesses available. Special shapes and intermediate thicknesses between those shown are also available.

JOHNS-MANVILLE JM PRODUCTS **Johns-Manville** *first in* **INSULATIONS**

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

FOR 81 MM MORTARS—Steel slugs, at left, are cut from 2½-in. round bars of carbon steel; next, the slugs are upset (center).

Heated to 2100 F, the upset slugs are extruded and formed into rough cups (right). The final product, not shown, is then cold-shaped to close tolerances.

SCENE OF ACTION—In this 1600 ton press, the upset slugs, heated to 2100 F, are cupped by the extruding punch at upper right. The forming die, at upper left, then shapes the cupped piece to more accurate shape. High-pressure jets of mixed air and water keep the punches and dies cooled to about 550 F. Punches and dies, made from Cr-Mo-W tool steel, are hardened and double-tempered to produce a hardness of Rockwell C 50.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Care is required when cutting tool steel with abrasive wheels.

Cutting annealed tool steel with an abrasive cut-off wheel can cause both fine cracks and scorching on the surface unless certain precautions are observed.

Proper wheel speeds and the liberal use of coolant will help to avoid this sort of trouble. If these precautions are ignored, the excessive heat generated is often so intense that an annealed steel is actually hardened.

If the steel is heated above the critical range, the rapid conduction of heat to the adjacent cold steel serves as a quench. Hardnesses above Rockwell C-60 are often produced on surfaces which have been cut in this manner. Attempts to drill or machine such surfaces will result in trouble because the hardness is often high enough to make machining impossible.

Slugs Formed Into Mortar Shells 500 an Hour, at 2100 F

Production men at the Ordnance Division of Rheem Mfg. Co., San Pablo, Calif., have good reason to be pleased with the long service life they've been getting from extrusion punches and forming dies made from our Chrome-Moly-Tungsten hot-work tool steel.

Hot slugs, to be processed into mortar shells, are extruded into a cupped shape by punches at the rate of 500 an hour. Because they are in such frequent contact with the slugs, heated to 2100 F, the temperature of the punches seldom falls below 550 F, even though the punches are sprayed with an air and water mixture.

The production men and tool designers at Rheem figured the punches would produce a maximum of 3,000 to 5,000 pieces before failure. Instead, one punch extruded 30,860 pieces; others produced 14,000 and 16,000.

The hot forming dies, which form the cupped piece into more finished shape, are subjected to the same high temperatures. After forming 15,000 cups, one of these dies was polished and put back in service; it turned out another 63,000 pieces before it showed much wear.

Cr-Mo-W is an all-around hot-work steel containing 5 pct chromium. It's especially suited for jobs that involve both shock and repeated cycles of heating and drastic cooling. It's easy to machine and heat-treat; and it's highly resistant to heat-checking when water-cooled.

Cr-Mo-W hardens in air and distorts very, very little during heat-treatment. It's widely used for gripper and header dies, shear blades, trimmers, die-casting dies. Like to have more details? Write for Booklet 265. Address your request to Publications Dept., Bethlehem, Pa.

An experienced spark-tester can identify the basic composition of this bar of tool steel. Can you?

KNOW YOUR SPARKS

The exact composition of a tool steel cannot be determined except by a laboratory analysis. However, the spark test is often convenient when bars of several different compositions become mixed.

Even amateurs sometimes use the spark test with good results by spot-grinding a bar of known analysis and comparing the spark stream with bars of unknown composition. A small-diameter grinding wheel, rotated at high speed to produce a generous flow of sparks, is recommended for this test. Note the illustration.

Some elements such as carbon, tungsten or molybdenum have characteristic appearances in the spark stream. Other elements such as silicon and nickel modify the appearance of other elements.

Perhaps you are expert enough to recognize the sparks at the left. They indicate a steel having a fairly high carbon content (0.90 pct) and some tungsten (0.50 pct). It's our BTR, most popular of the general purpose, oil-hardening grades.

Set screw for coal-cutter chain

TOUGHNESS!

Fan shaft and oil impeller for automobile water pump

HARDNESS!

Socket for mechanic's socket wrench

STRENGTH!

Each Achieved With the Right REPUBLIC COLD DRAWN ALLOY STEEL BARS

Here are examples of alloy steel parts made by Republic customers. Each was searching for a certain outstanding characteristic . . .

One wanted the edges of a set-screw for a coal-cutter chain to be tough enough to resist rounding off when dragging through a coal seam deep in a mine . . .

The next one wanted an automobile water-pump shaft hard enough to resist thousands of miles of high-speed service without becoming worn and leaky . . .

The third wanted a socket-wrench with a socket that was stronger than the heaviest-handed mechanic . . .

All three manufacturers called in the Republic Field Metallurgist . . . discussed their three different problems with him . . . got a triple-distilled alloy-choice that was part his, part the Republic Mill Metallurgist's, part the Republic Laboratory Metallurgist's.

Each customer is using a different Republic Cold Drawn Alloy Steel Bar grade . . . all three got the high surface quality, the close dimensional tolerance, the high strength, and the UNIFORM MACHINABILITY that helped cut production costs, increase tool life, improve product quality.

Want to try Republic 3-Dimension Metallurgical Service on *your* production problems? A call to your Republic District Sales Office will start action.

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

LAB FIELD MILL
3-DIMENSION Metallurgical Service

...combines the extensive experience and co-ordinated abilities of Republic's *Field, Mill* and *Laboratory* Metallurgists with the knowledge and skills of your own engineers. It has helped guide users of Alloy Steels in countless industries to the correct steel and its most efficient usage. IT CAN DO THE SAME FOR YOU.

Republic COLD DRAWN REPUBLIC STEEL ALLOY STEEL BARS

if it has to do with

x-ray

it has to do with

PICKER

x-ray

Picker *specializes* in x-ray, and x-ray only, covering the field like a blanket. *Whatever you need, we've got . . .* from a simple lead letter to a 22,000,000 volt betatron. To serve you, there are sales offices and service depots in all principal cities, staffed by skilled engineers prepared to cope with ány x-ray problem promptly and with understanding. If you are now using x-ray, or are wondering whether you should, you can depend on Picker for objective technical counsel and efficient handling.

PICKER X-RAY CORPORATION 25 S. Broadway, White Plains, N.Y.

SALES OFFICES AND SERVICE DEPOTS IN PRINCIPAL CITIES OF U.S.A. AND CANADA

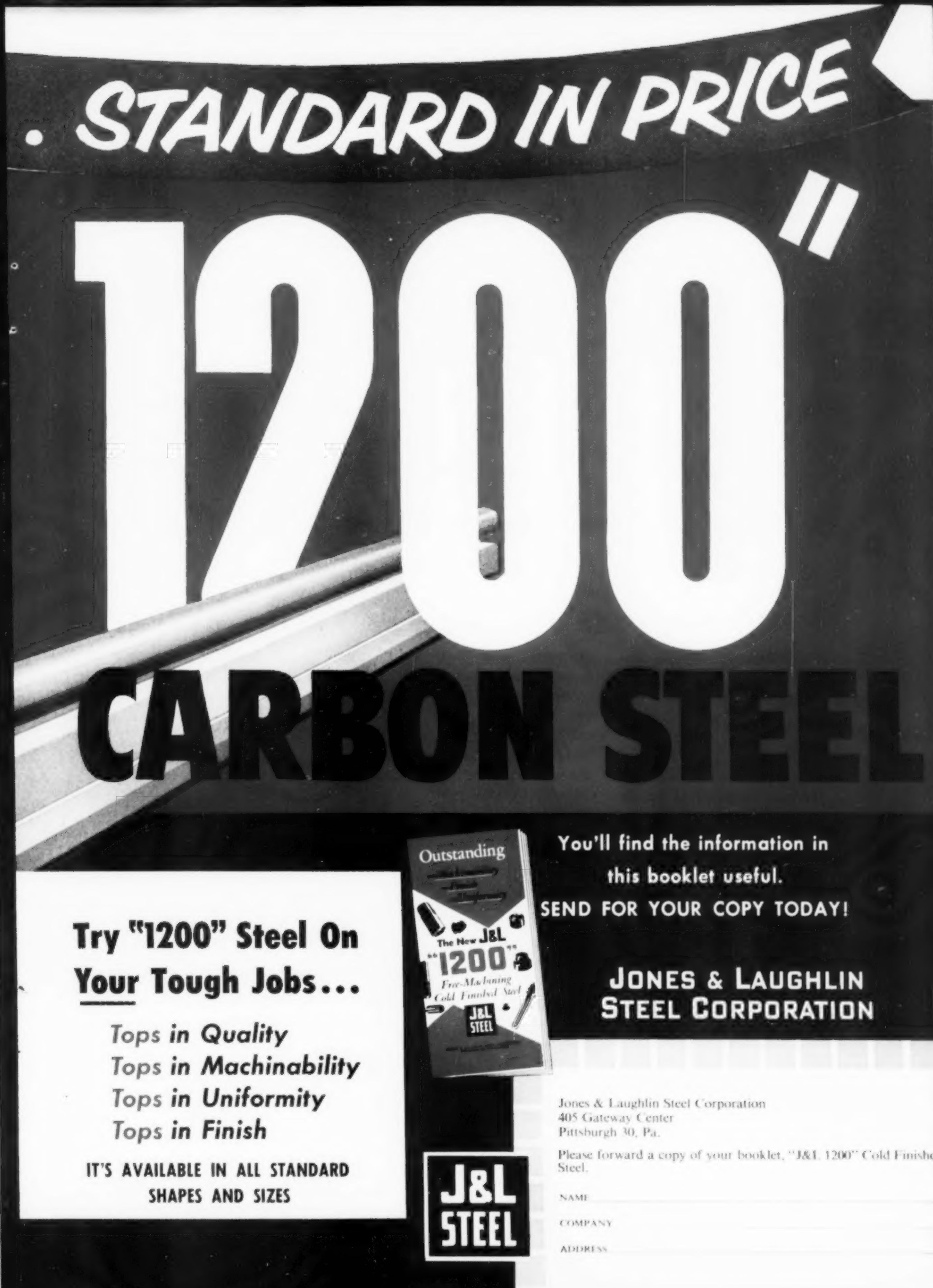
TOPS IN QUALITY...

The NEW "J&L" COLD FINISHED

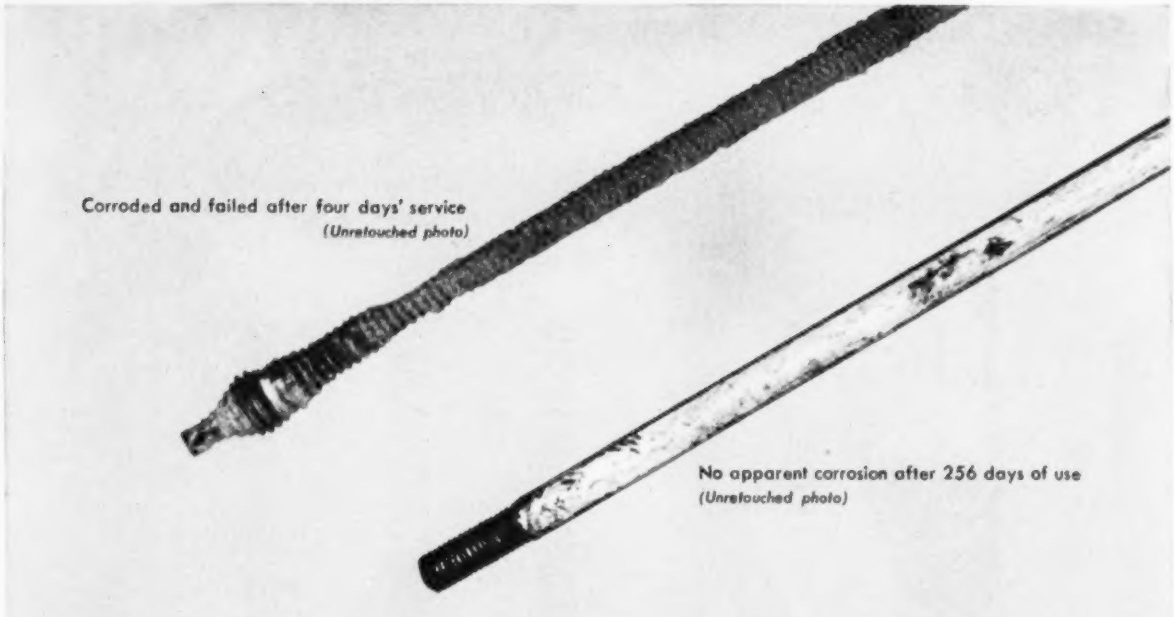
UNSURPASSED AMONG FREE-MACHINING STEELS

"J&L 1200" Steel, most recent of the corporation's many Cold Finished firsts has already proved itself in Screw Machine Shops throughout the industry. More and more evidence of the outstanding performance of this new free-machining steel is constantly being furnished by reports from the growing number of machine shops who regularly specify "J&L 1200" Cold Finished Steel for their production runs.

"J&L's 1200" series meets equivalent compositions published by the American Iron & Steel Institute, the Society of Automotive Engineers, and Federal Specifications QQS-663.



. . STANDARD IN PRICE
"1200"
CARBON STEEL
Outstanding
The New J&L
"1200"
Free-Machining
Cold Finished Steel
J&L
STEEL
You'll find the information in
this booklet useful.
SEND FOR YOUR COPY TODAY!
Try "1200" Steel On
Your Tough Jobs...
Tops in Quality
Tops in Machinability
Tops in Uniformity
Tops in Finish
IT'S AVAILABLE IN ALL STANDARD
SHAPES AND SIZES
JONES & LAUGHLIN
STEEL CORPORATION
J&L
STEEL
Jones & Laughlin Steel Corporation
405 Gateway Center
Pittsburgh 30, Pa.
Please forward a copy of your booklet, "J&L 1200" Cold Finished Steel.
NAME
COMPANY
ADDRESS



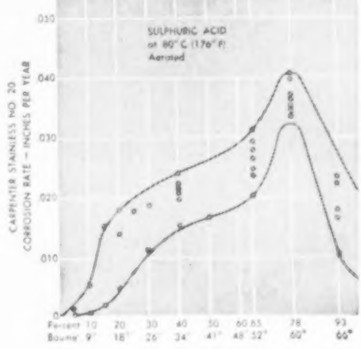
Corroded and failed after four days' service
(Unretouched photo)

No apparent corrosion after 256 days of use
(Unretouched photo)

Is the Handling of Corrosive Acids, such as Sulphuric, Causing Headaches in Your Plant?

Today many plants are enjoying new freedom from corrosion, longer equipment life and fewer shutdowns . . . because of Carpenter Stainless No. 20. Take the job shown above. In this application, ½″ rd. rods of Carpenter No. 20 and Stainless Type 316 were installed to handle H_2SO_4 at the rate of about 50 gallons a minute in a full range of solution varying from 0% up to 58% concentration. Temperature: 70° C. (158°F.). After four days the Type 316 rods failed and were replaced with ½″ sq. No. 20 rods. After being in service 3,747 hours of a possible 6,144 hours over a period of 256 days, the No. 20 rods showed no apparent corrosion whatsoever. (See unretouched photo above.) Of course, Type 316 is satisfactory for certain dilute solutions of H_2SO_4 and many other corrosive conditions. But with a tough problem like the one described here, it takes No. 20 to do the job.

While the production of Stainless No. 20 is controlled by Government Regulations, you may be able to obtain Government approval of its use, depending on the nature of your job. If not, keep these facts in mind because of their importance in your planning for future products. Meantime, write on your Company letterhead for more details in the No. 20 booklet. Also, get in touch with us for No. 20 test coupons. We'll be glad to work with you. The Carpenter Steel Company, 133 W. Bern St., Reading, Pa.

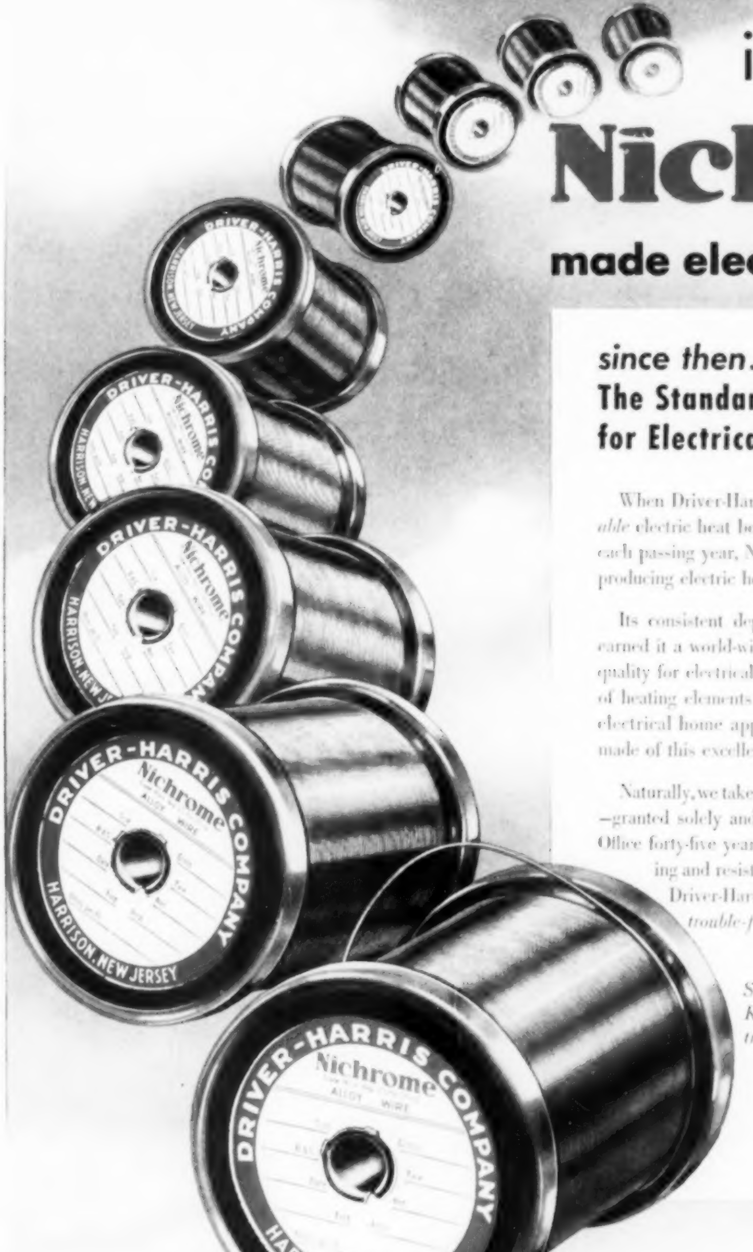


Carpenter STEEL

Stainless No. 20

Export Department: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"

Mill-Branch Warehouses and Distributors in Principal Cities Throughout the U.S.A. and Canada



in 1908

Nichrome*

made electric heat possible!

since then... The Standard of Quality for Electrical Alloys

When Driver-Harris introduced Nichrome* in 1908, *dependable* electric heat became possible for the first time. And with each passing year, Nichrome looms larger as the *ideal* alloy for producing electric heat in domestic and industrial equipment.

Its consistent dependability and unique performance have earned it a world-wide reputation—and made it *the* standard of quality for electrical alloys. That's why today, the great majority of heating elements of all types—in applications ranging from electrical home appliances to large industrial furnaces—are made of this excellent alloy.

Naturally, we take particular pride in our trademark: Nichrome—granted solely and wholly to us by the United States Patent Office forty-five years ago. Representing a series of superb heating and resistance alloys, developed and produced *only* by Driver-Harris, this trademark symbolizes *long life* and *trouble-free* operation to manufacturers everywhere.

Sole producer of Nichrome, Advance*, Karma* and over 80 other alloys for the electrical, electronic and heat-treating industries.*

*T.M. Registered in United States Patent Office by Driver-Harris Company August, 1908

Driver-Harris Company

HARRISON, NEW JERSEY

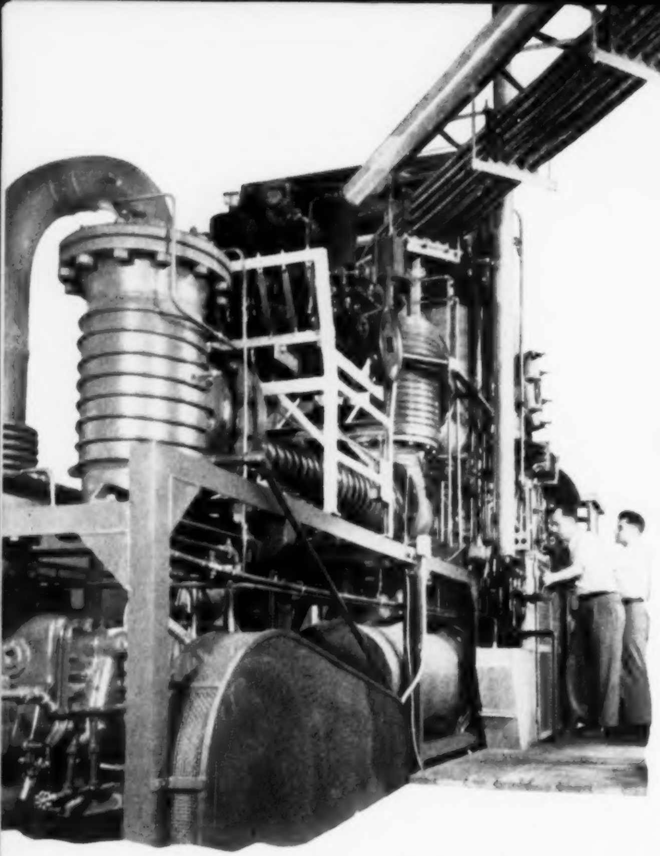
BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

SPECIAL PURPOSE ALLOYS SINCE 1899 · D/H · TRADE MARK REG. U. S. PAT. OFF.

Manufactured and sold in Canada by The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

Factories: U.S.A., CANADA, ENGLAND, IRELAND, FRANCE, ITALY, SPAIN Representatives in 38 COUNTRIES

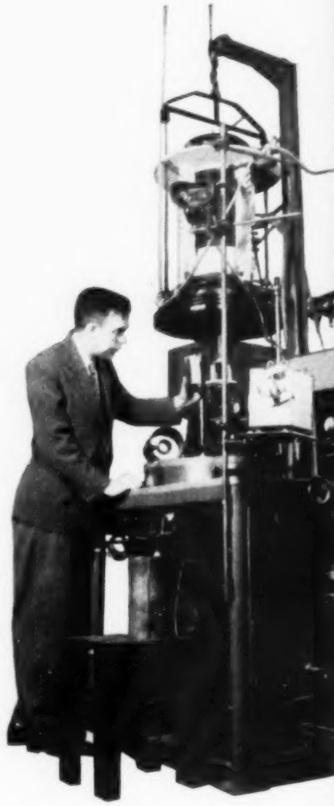
MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE AND ELECTRONIC ALLOYS IN THE WORLD



sintering
melting
annealing or
casting . . .

CVC can put high vacuum to work for you

This high vacuum furnace at Climax Molybdenum Company sinters, melts, and casts malleable, ductile "moly" in half-ton ingots. A uniquely economical CVC oil ejector pump creates the vacuum in the sizable chamber needed and gets rid of the gases evolved.



The Mineral Products Division of the National Bureau of Standards uses a CVC high vacuum furnace to study phase equilibria of binary and ternary metal-ceramic mixtures. Operating at 10^{-4} to 10^{-5} mm Hg, the furnace heats to 1800°C in ten minutes.

When you get rid of every possible molecule of air in a chamber, some very useful things happen.

For one thing, at pressures of 1×10^{-4} mm Hg, oxygen content is reduced to as little as 3 parts per billion. Casting, sintering, annealing, and purifying oxygen-sensitive metals is simplified. And it is usually easier and cheaper to get rid of oxygen than trying to dilute it.

Moreover, the negligible thermal conductivity in vacuums of this order makes heating faster, high temperatures easier to hold.

To make high vacuum a practical, economical metallurgical process, CVC has combined its own years of experience in solving high vacuum problems with expert manufacturing experience in metal-heating problems. We can supply vacuum furnaces with provisions for interchangeable furnace assemblies, sight windows, addition cups or whatever you need—and still hold high vacuum. And we know the answers to such problems as furnace insulation under vacuum, handling of volatile components of the melt, designing for trouble-free operation and ease of maintenance.

Whether you are interested in a high vacuum furnace for volume production or research, in vacuum dehydration, or in a single pump, we welcome the opportunity to talk with you. Just write or phone **Consolidated Vacuum Corporation, Rochester 3, N. Y.** (A subsidiary of Consolidated Engineering Corporation, Pasadena, Calif.) Sales offices: Menlo Park, Calif. • Chicago, Ill. • Camden, N. J. • New York, N. Y.

CVC

formerly DPi
Vacuum Equipment Dept.

Consolidated Vacuum Corporation

Rochester 3, N. Y.

high vacuum research and engineering

How Hot can a Jet Get?

Whooosshh! Jet engines generate a powerful amount of heat . . . heat which, uncontrolled in flight, would cause disastrous metallurgical distortions within the delicately balanced engine. So the problem is . . . or rather *was* . . . how to provide a dependably accurate means of measuring exhaust temperatures so that the pilot might have control over how hot his jets get.

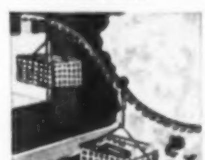
And the answer? Special wiring harnesses running from engine to instrument panel . . . harnesses now made exclusively with Hoskins Chromel-Alumel thermocouple alloys.

Yes, wherever durability and accuracy are required in a thermocouple . . . whether for jet engines or industrial furnaces . . . you'll find Chromel-Alumel *right* for the job. Extremely durable . . . highly resistant to heat, corrosion, oxidation . . . guaranteed to register true temperature-E.M.F. values within specified close limits.

That's only part of Hoskins' product picture, though. Other specialized quality-controlled alloys developed and produced by Hoskins include: Alloy 785 for brazing belts; Alloy 717 for facing engine valves; special alloys for spark plug electrodes; Alloy 502 for heat resistant mechanical applications. And, of course, there's Hoskins CHROMEL . . . the *original* nickel-chromium resistance alloy used as heating elements and cold resistors in countless different products.

Heating elements made of Hoskins Chromel deliver full-rated power throughout their long and useful life.

Sparks fly better, last longer in today's spark plugs . . . thanks to Hoskins' spark plug electrode alloys.



Hot stuff for hot jobs! Hoskins Alloy 502 is ideally suited to many mechanical-structural applications.

Chromel
NICKEL CHROMIUM WIRE

HOSKINS

MANUFACTURING COMPANY

4445 LAWTON AVENUE, DETROIT 2, MICHIGAN

Furnace linings last longer

when they are made of Norton-engineered Special Refractories

Fewer shut-downs and more continuous operation is always the story when linings are made of Special Refractories engineered to your job by Norton. Whether you are melting ferrous or non-ferrous metals there are Norton mixtures for a wide variety of successful applications that mean more metal melted per lining, fewer furnace shut-downs and generally lower costs.

There are so many complications in metal melting, involving chemical, electrical and physical conditions it will pay you to take advantage of Norton's 40 years' experience in solving Special Refractory problems like yours.

Many different materials

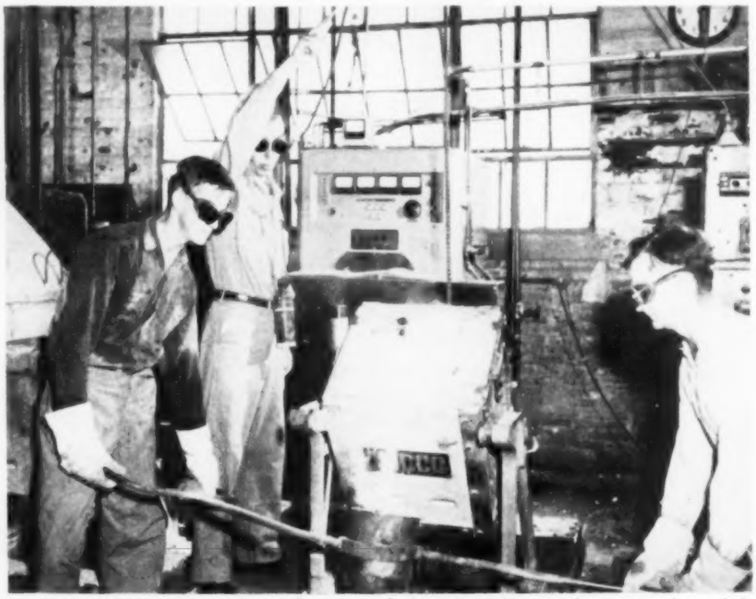
Norton furnishes Special Refractory grain, cements and bonded shapes in a wide variety of mixtures each engineered for a particular set of conditions.

Such special Refractory Materials as CRYSTOLON* (silicon carbide), ALUNDUM*, FUSED STABILIZED ZIRCONIA.

What is your problem?

We believe you will benefit by consulting your nearby NORTON Representative or writing Norton Company, 326 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

Taking the Temperature reading on the melt at the Metalmold Corporation plant at Groton, Mass. Temperatures go 3200° F. and higher. MAGNORITE* grain placed between the crucible and the coil has such high rammed density that it offers great resistance to penetration, erosion and chemical attack.



Longer Life for Furnace Linings can be expected when the right special refractory is used. In this plant they count on MAGNORITE to prevent short circuits in the event of crucible breakage. MAGNORITE keeps metal from reaching the primary coil of the furnace.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

NORTON

Special REFRACTORIES

Making better products to make other products better

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

Metal Progress . . . . . . July 1953 Vol. 64, No. 1

Ernest E. Thum
Editor

Marjorie R. Hyslop
Managing Editor

John Parina, Jr.
Associate Editor

Harold J. Roast
E. C. Wright
Consulting Editors

Floyd E. Craig
Art Director

Edith W. Bennington
Editorial Assistant

R. L. Wilson
James Austin
F. S. Badger
John L. Christie
L. S. Fletcher
F. G. Norris
Roy G. Roshong
Leo Schapiro
Editorial Advisory Board

Copyright, 1953, by AMERICAN SOCIETY FOR METALS, 7301 Euclid Ave., Cleveland 3, Ohio. Published monthly, subscription $7.50 a year in U.S. and Canada; foreign $10.50. Single copies $1.50; special issues $2.00. Entered as second-class matter, Feb. 7, 1921, at the post office at Cleveland, under the Act of March 3, 1879 . . . The AMERICAN SOCIETY FOR METALS is not responsible for statements or opinions printed in this publication . . . Requests for change in address should include *old* address of the subscriber, missing numbers due to "change in address" cannot be replaced. Claims for nondelivered copies must be made within 60 days.

Engineering Articles

Critical Points

Correspondence

Digests of Important Articles

Departments

Sure of your Alloys?

Call Ryerson and Be Sure, 8 Ways!

Like the bar in this picture, *every bar* of Ryerson alloy steel has its mark—a symbol that identifies the particular heat from which the bar was rolled. And on all but the smallest bars this heat symbol is unmistakably stamped into the steel itself.

The result: Positive heat identification, just one of eight ways that we protect you against the many slips that could occur before the alloy steel you order reaches you.

Your protection begins with careful selection of the heats to be carried in our stock. Next, analysis is verified and all Ryerson alloys are spark tested to guard against mixed steels. Then the bars are color marked and stamped to identify type and heat.

Meanwhile, we test a sample of every heat for hardenability and interpret the test results for you. So, finally, when you call Ryerson for alloys, you can be SURE—sure of the steel you get and sure of what it will do.

Tested steel—racked separately by heats—is taken from stock; prepared to your specification; given a final inspection and shipped to you quickly. And with your steel (as-rolled or annealed), you receive complete test data to verify quality and guide your heat treatment.

This 8-point quality control is yours, at no extra cost, from Ryerson—and only from Ryerson. Just call your nearby Ryerson plant.

PRINCIPAL PRODUCTS IN STOCK: CARBON, ALLOY & STAINLESS STEEL—BARS, STRUCTURALS, PLATES, SHEETS, TUBING, ETC.

RYERSON STEEL

JOSEPH T. RYERSON & SON, INC. PLANTS AT: NEW YORK • BOSTON • PHILADELPHIA • CINCINNATI • CLEVELAND • DETROIT
PITTSBURGH • BUFFALO • CHICAGO • MILWAUKEE • ST. LOUIS • LOS ANGELES • SAN FRANCISCO • SPOKANE • SEATTLE

By ROBERT N. IMHOFF, 2d Lt., U.S.A.F., Project Engineer
and JAMES W. POYNTER, Chief, Steel Section, Materials Laboratory
Wright Air Development Center, Dayton, Ohio

81B40

81B40

In our previous *Metal Progress* article, some information on the metallurgical characteristics of a heat of 86B45 and one of 80B30 steel was presented. In the present paper the results obtained on 81B40 steel are to be given. This work comprises parts of the extensive program being conducted by the Directorate of Research, Wright Air Development Center, U. S. Air Force, to evaluate some of the boron-treated steels as substitutes for the low-alloy steels such as 4130, 4340, 8630, 4140, 8740, used in many aeronautical applications.

The material for study consisted of 1¼-in. round bars received from Republic Steel Corp.* Although this heat, similar to others previously studied, was not produced as "aircraft quality" it is believed that the results we obtained will at least indicate what can be expected from minimum "aircraft quality" steel.

Chemical analyses in Table I show that the carbon content is 0.01% over the maximum of the American Iron and Steel Institute 81B40 range and the chromium 0.05% lower. However, the carbon content is within the 0.02% tolerance in check analysis. The chromium content of this steel was originally set up as 0.30 to 0.50% in March 1951, and changed to 0.35 to 0.55% on March 25, 1952. Consequently, this heat of steel is within the specified range for chromium at the time it was melted. Presence of an appreciable amount of vanadium should be noted. This is significant in evaluating the results, since vanadium is specified in some of the boron-treated steels (for example, 43BV10 and 98B40 modified) to improve hardenability.

To insure uniformity for the subsequent tests, the bar stock was normalized at 1625° F. for 1 hr. at temperature and air cooled.

The optimum quenching temperature of the steel is determined by end quenching duplicate hardenability specimens from 1500, 1550, 1600 and 1650° F. The results (Fig. 1) show little difference, but the quench from 1550° F. gives slightly higher hardness values beyond ½ in. from the quenched end. Consequently, this temperature was selected for subsequent heat treatments.

At 1550° F. the austenitic grain size is found to be A.S.T.M. No. 7 to 8, using the oxidation method (Method C of Federal Specification QQ-M-151).

The top sketch of Fig. 1 shows that the end-quench hardenability of our steel is approximately at the median of the band for TS81B40H up to 12 to 14 sixteenths, but then hugs the lower limit of the band for slower cooling rates.

The curve obtained by end quenching from 1550° F. falls within two points Rockwell C of the top of A.I.S.I. hardenability band for 4140H steel to about

Table I – Composition of 81B40 Steel Under Test

Element	A.I.S.I. Standards		Ladle Analysis	Bar Analysis
	TS81B40	TS81B40H		
Carbon	0.38 to 0.43%	0.37 to 0.45%	0.40%	0.44%
Manganese	0.75 to 1.00	0.70 to 1.05	0.91	0.85
Silicon	0.20 to 0.35	0.20 to 0.35	0.33	0.32
Nickel	0.20 to 0.40	0.20 to 0.40	0.28	0.25
Chromium	0.35 to 0.55	0.30 to 0.60	0.31	0.30
Molybdenum	0.08 to 0.15	0.08 to 0.15	0.12	0.13
Sulphur	0.04 max.	0.04 max.	0.035	0.03
Phosphorus	0.04 max.	0.04 max.	0.018	0.02
Aluminum	—	—	—	0.03*
Boron	0.0005 min.	0.0005 min.	—	0.0008*
Vanadium	—	—	—	0.04 to 0.08*

*Values determined spectrographically.

*Grateful acknowledgment is again made of the cooperation of D. A. Ruhnke and E. S. Bower of Republic Steel Corp. in making the steel available and of the assistance of personnel of the Materials Laboratory, Directorate of Research, Wright Air Development Center, in the test program.

Hardenability of 81 B 40

the 10/16-in. location from the quenched end (middle of Fig. 1). It then drops rather rapidly and falls below the band minimum at 24 sixteenths.

When compared with the A.I.S.I. band of 8740H (bottom of Fig. 1), the curve for 1550° quench is close to the top of the band at the quenched end and exceeds the band maximum at 10 sixteenths. Beyond that the curve drops to somewhat less than the band median at 32 sixteenths from the quenched end.

From these comparisons in Fig. 1, the steel we investigated would have hardenability on the high side of expectancy for a heat of TS81B40H, 4140H or 8740H to 8 or 10 sixteenths (good hardness throughout small parts) but would be on the low side for more massive parts.

Tensile tests on 0.75-in. rounds, heat treated and then machined to 0.505-in. standard specimens, are given in Table II. As with 80B30 and 86B45 previously described in *Metal Progress* for March 1953, the tensile and yield strengths of the normalized boron steel are somewhat less than those of the standard steels of comparable hardenability. This substantiates the belief that boron is not an effective strengthener when the steel is in the normalized condition. Figures in italic in Table II represent commercial averages; those for 4140 are taken from "Republic Alloy Steels" and for 8740 are from Bethlehem's "Properties of Frequently Used Carbon and Alloy Steels", 1946. (This steel had an analysis high in molybdenum and nickel, 0.28 and 0.53% respectively.)

The oil quenched, 300° F. stress-relieved tensile specimens of 81B40 show reasonably good ductility with high tensile strength. Experimental difficulties with quench cracking, similar

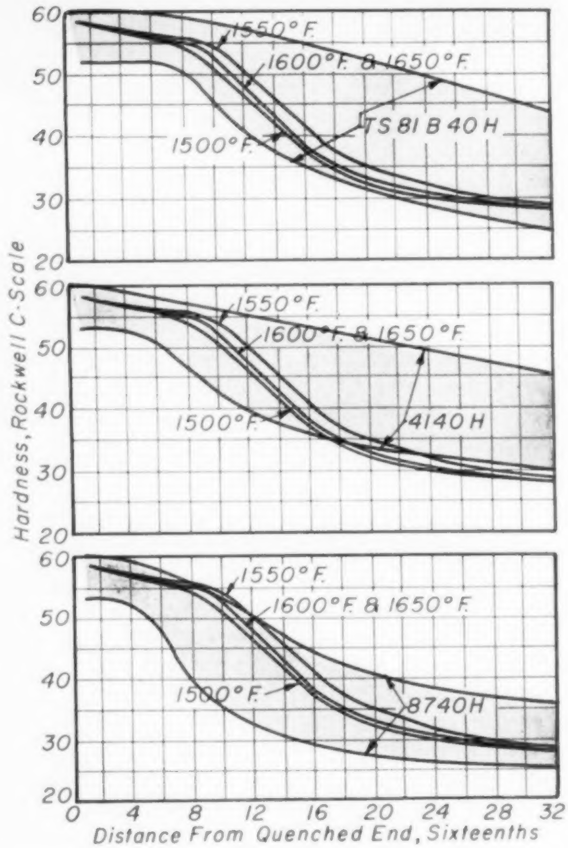


Fig. 1 – Comparison of Jominy End-Quench Curves for One Heat of 81B40 Steel With Established Bands for TS-81B40H, 4140H and 8740H

Table II – Tensile Properties of 81 B 40

(Averages of three; heat treated in ¾-in. rounds; normalized 1 hr. at 1625° F.; austenitizing temperature 1550° F. for 1 hr.; tempered 1 hr.; air cooled from tempering)

Treatment	Yield†	Ultimate	Elong.	R.A.	Hardness
Normalized	75,000	118,000	21	58	B-96
4140	*95,000*	*132,000*	*22*	*45*	
Oil quenched (O.Q.)*	179,000	317,000	11	36	C-56
Water quenched (W.Q.)*	218,000	321,000	11	39	C-56
O.Q., tempered 600° F.	220,000	253,000	10	46	C-50
4140	*207,000*	*225,000*	*10*	*43*	*C-47*
8740	*226,000*	*250,000*	*12*	*45*	
O.Q., tempered 900° F.	165,000	176,000	14	55	C-37
4140	*140,000*	*158,000*	*16*	*54*	*C-35*
8740	*180,000*	*190,000*	*14*	*52*	
O.Q., tempered 1035° F.	136,000	150,000	16	56	C-32
4140	*115,000*	*130,000*	*19*	*59*	*C-27*
8740	*162,000*	*170,000*	*17*	*55*	
O.Q., tempered 1250° F.	100,000	117,000	22	62	B-97
4140	*90,000*	*105,000*	*24*	*64*	
8740	*118,000*	*133,000*	*22*	*62*	
W.Q., tempered 600° F.	218,000	245,000	11	49	C-49
Military Specification‡	**100,000**	**125,000**	**17**	**55**	

*Oil or water quenched specimens were stress relieved at 300° F. for 3 hr.
†At 0.2% offset.
‡Minimum values for heat treated 4140 in sections up to 2 in. (MIL-S-5626), and for 8740 in sections up to 1¾ in. (Specification MIL-S-6049).

to those experienced with the 86B45, prevented the accurate determination of the mechanical properties of the water quenched specimens; the data in the fourth line of Table II represent one sample only.

Little difference is found between the mechanical properties of the oil quenched and water quenched specimens of 81B40 when both are drawn at 600° F. Comparing the as-quenched specimens with those after tempering at 600° F., it will be noted that tensile strength is appreciably reduced, yield strength and reduction in area significantly increased, and elongation unchanged. Tempering at 600° F. has much more effect on the mechanical properties of this steel than it had on those of the 80B30 described in *Metal Progress* in March; the principal effect of the 600° draw was to increase the yield 39,000 psi. (from 152,000 to 191,000).

In the 115,000 to 175,000-psi. tensile strength range (900 to 1250° F. tempering range), the mechanical properties of 81B40 fall near the middle of the scatter bands predicted by W. G. Patton in his May 1943 article in *Metal Progress*, p. 726.

Minimum values of 125,000 psi. tensile, 100,000 psi. yield, 17% elongation and 55% reduction in area are required for quenched and tempered 4140 steel in sections up to 2 in. in least dimension and for quenched and tempered 8740 steel in sections up to 1¾ in. by Military Specifications MIL-S-5626 and MIL-S-6049, respectively. Table II shows that these specified properties can be met readily by this 81B40 steel by the proper selection of a tempering temperature between 1050 and 1250° F.

Tensile and Impact Properties

Toughness – Using the same type of notched specimens described in our previous *Metal Progress* article on 86B45 steel, notched and unnotched tensile properties of this steel were determined at the 170,000 to 190,000-psi. and the 240,000 to 260,000-psi. strength levels and are compared with those of 4140 in Table III. Figures are average for three specimens.

Little difference in notch ductility (per cent reduction in cross section at the root of the notch) and no difference in notch strength ratio are noted between the two steels at the lower strength level. At the higher strength level, however, the notch ductility as measured by elongation is greater in the boron-treated steel and the notch strength ratio somewhat higher. The loss in strength due to notching is considered small in both steels at this high strength level, and these results indicate that the two steels are equally notch-sensitive.

Low-temperature impact properties and susceptibility to temper brittleness are of special interest because of the conditions at which aircraft sometimes operate. The results of V-notch Charpy impact tests over a range of temperatures on various conditions of this 81B40 steel (three tests at each temperature for each condition) are given in Fig. 2 and compared with values reported in the literature for 4140. The results obtained on the quenched and tempered 81B40 are believed to represent nearly optimum results for quenched and tempered martensite since the test specimens were treated in sizes only slightly larger than the required 0.394-in. squares.

Table III – Plain Versus Notched Tensile Tests of 81B40 and 4140

Steel	Treatment*	Variety	0.02% Yield	Ultimate	Elongation	Reduction of Area	Hardness	Notch Strength Ratio
		Comparison at 240,000 to 260,000 Strength Level						
81B40	A	Unnotched	220,000	253,000	10	46	C-50	1.12
		Notched	–	284,000	1	3.5	C-50	
4140	A	Unnotched	201,000	243,000	9	41	C-48	1.09
		Notched	–	266,000	1	2	C-48	
		Comparison at 170,000 to 190,000 Strength Level						
81B40	B	Unnotched	165,000	176,000	14	55	C-37	1.16
		Notched	–	204,000	3	7.5	C-39	
4140	C	Unnotched	165,000	179,000	14	56	C-40	1.16
		Notched	–	208,000	3.5	8	C-39	

*Heat Treatments – A: Normalized 1 hr. at 1625° F., oil quenched after 1 hr. at 1550° F.; tempered at 600° F., 1 hr., air cooled.
B: Same as A, except tempered at 900° F.
C: Same as A, except tempered at 925° F.

Susceptibility to Temper Brittleness

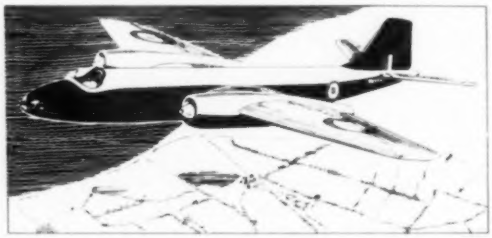
As would be predicted, the energy values of the 81B40 in the normalized condition are inferior to those of 4140. This is also true for quenched and tempered specimens at Rockwell C-37 to 39 hardness (tempered at 900°) when compared with 4140 tempered at 1000° F. (C-36) at all testing temperatures, except the lowest; at −108° F. the impact strengths of the two steels are similar, around 25 ft-lb. However, at low tempering temperatures (600° F.) giving the higher hardness of C-49, the impact properties of the quenched and tempered 81B40 are superior to those of 4140 throughout the range of testing temperatures.*

Of the 81B40 specimens which received the 900° temper, those water quenched give impact values 2 to 5 ft-lb. higher than those furnace cooled over the entire temperature range. This indicates that 900° F. is within the range in which the phase responsible for temper brittleness is precipitated. (Even larger differences exist in the impact energy of 4140, depending on the speed of cooling from the 1140° F. draw temperature.)

Similarly, some susceptibility to temper brittleness is found in bars of 81B40 tempered at 1035° F., since water quenched specimens give energy values 7 to 12 ft-lb. higher than those furnace cooled from the tempering temperature. (The high value for the latter when tested at 32° F. is an anomaly.) Moreover, the change in appearance of fracture from ductile to brittle occurs at a higher test temperature (zero versus −65° F.) for specimens that have been furnace cooled.

The double tempering treatment is designed to produce temper brittleness in susceptible steels. Initial tempering at a high temperature (1100° F.) would assure a relatively high impact energy level (when tested at temperatures above the so-called "transition temperature"), while a second and longer tempering (4 hr. at 950° F.) is capable of precipitating the brittle phase. Our 81B40 steel attains its greatest toughness as measured by impact energy values and shows the most precipitous drop in energy values with testing temperature after receiving this double treatment. Its transition temperature is then located somewhere between −65 and −108° F.

The impact energy values of these 81B40 specimens given the double tempering treatment are similar to those reported for specimens of 4140 steel furnace cooled from 1140° F. and at comparable hardness levels (about C-30). Published data summarized in Fig. 2 indicate that 4140 is somewhat susceptible to



temper brittleness (compare specimens rapidly and slowly cooled from the tempering temperature). It therefore appears that 81B40 has about the same degree of susceptibility to temper brittleness as 4140.

Tests over a wider range of temperatures than were used in this investigation are needed before accurate determinations of the transition temperatures of 81B40 can be made. However, an approximation for the transition temperature resulting from each treatment, based on an estimate of the lowest temperature at which the fractures remain fibrous, is presented:

Normalized	Above room temperature
Oil quenched	Above room temperature
600° F. draw	Above room temperature
Both 900° F. draws	0° F.
1035° F. draw, air and furnace cooled	0° F.
1035° F. draw, water quenched	−65° F.
1150 and 950° F. (double draw)	−65° F. (two of three specimens)

The attack of the solution used to detect temper brittleness (picric acid, Rodalon and ether) is more pronounced on the double tempered specimens, indicating a greater degree of embrittlement. Similar behavior was noted on the 86B45 steel reported on previously. However, this cannot be taken as conclusive evidence of susceptibility to temper brittleness, since this etch attacks more severely as the tempering temperature is increased. Likewise,

*Editor's Footnote – Values in Fig. 2 for 4140, furnace cooled and water cooled after tempering at 1180° F., are from the minutes of a meeting on March 6, 1952, of the S.A.E. Iron & Steel Technical Committee. They seem to be out of place. The dashed curve for the 1000° temper is more in keeping with the hardness trend (note its relative position concerning lines for the 600 and 1140° tempers). Values for the 1000° F. temper are by M. Baeyertz and coworkers in Armour Research Foundation Report No. 22. This same document notes that 4140, tempered at 1200° F. and water cooled (hardness C-28), has Charpy impact values of over 95 ft-lb. from room temperature down to −65° F. and 85 ft-lb. at −108° F.

little difference in severity of attack is noted between the 81B40 specimens water quenched or slow cooled from the 1035° F. draw.

The split type of fracture, previously reported for the 80B30 and 86B45 steels, is found frequently in the impact specimens which give ductile fractures (that is, those tempered at 900° F. or above and broken above the transition temperature). Its extent in 81B40 is intermediate between that found in the 80B30 and the 86B45 steels, the 80B30 showing it most severely. In 81B40 steel both the split and the fibrous types of fracture are found in the same group of test specimens given identical heat treatments and tested at the same temperatures (Fig. 3). The specimens

with the fibrous fracture give the higher energy values. This fact might account for the somewhat higher average impact strength at 32° F. of the furnace cooled specimens tempered at 1035° F. (noted at A, Fig. 2), since split fractures are obtained in all specimens so heat treated and broken at 80° F. and −65° F., while only one specimen broken at 32° F. shows this type of fracture.

Tensile specimens tempered below 900° F. break with a cup and cone fracture; those tempered at 900° F. and above break with the star-type fracture which is believed to be intermediate between the cup and cone and

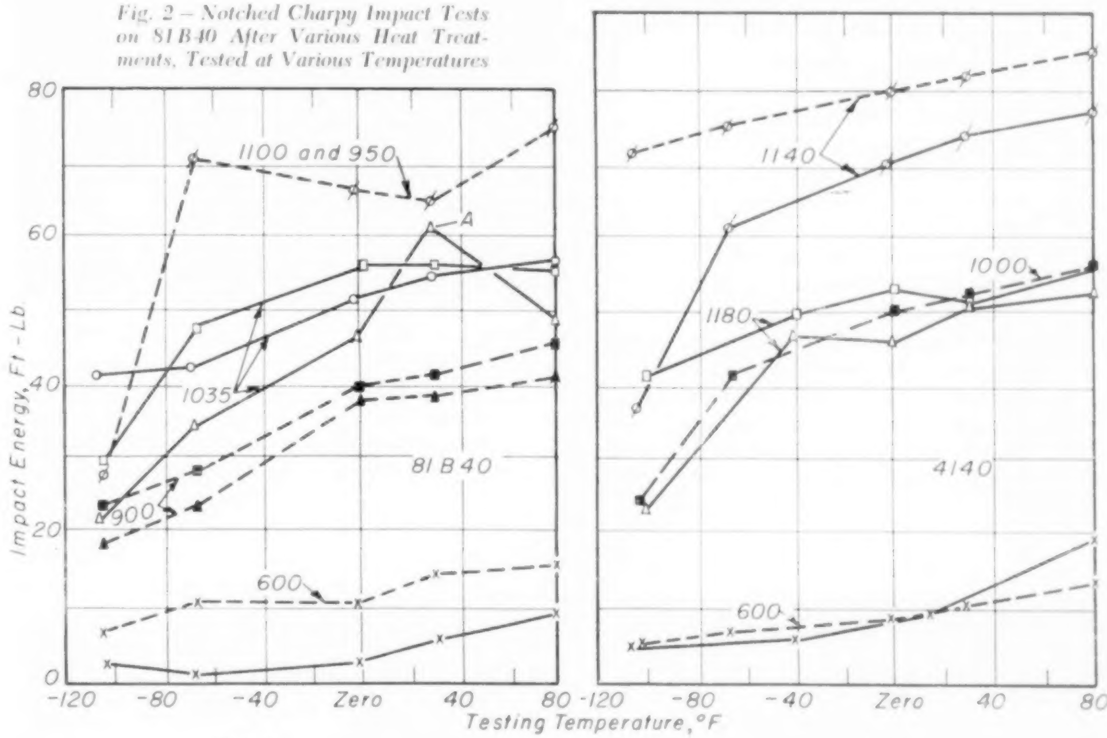


Fig. 2 – Notched Charpy Impact Tests on 81B40 After Various Heat Treatments, Tested at Various Temperatures

81B40 Hardness	81B40 Heat Treatment*	Legend	4140 Heat Treatment*	4140 Hardness
C-19 to 26	Normalize (1625)	——x——	Normalize	C-24
C-49 to 50	O.Q.; T. 600; A.C.	- - - -x- - - -	O.Q.; T. 600; W.Q.	C-49
C-32 to 34	O.Q.; T. 1035; A.C.	——○——	—	
C-32 to 34	O.Q.; T. 1035; F.C.	——△——	O.Q.; T. 1180; F.C.	C-31
C-32 to 34	O.Q.; T. 1035; W.Q.	——□——	O.Q.; T. 1180; W.Q.	C-31
C-37 to 39	O.Q.; T. 900; F.C.	— —▲— —	—	
C-38 to 39	O.Q.; T. 900; W.Q.	— —■— —	O.Q.; T. 1000; W.Q.	C-36
C-27 to 29	Double Temper†	- - - -ø- - - -	O.Q.; T. 1140; O.Q.	C-31.5
		——ø——	O.Q.; T. 1140; F.C.	C-31.5

*O.Q. = oil quenched; T. = tempered; A.C. = air cooled; W.Q. = water quenched; F.C. = furnace cooled.
†Oil quenched; tempered 1 hr. at 1100° F.; water quenched; re-tempered 4 hr. at 950° F.; air cooled.

the split type. Fractures of the tensile specimens tempered at 1035° F. more closely approach the split type but none of these are as severe as the split fractures observed in some of the 80B30 tensile specimens. Unlike specimens of the other boron steels tested, one notched tensile specimen of 81B40 tempered at 900° F. fractured with the split effect (Fig. 4).

Hollomon considers the longitudinal or split fracture and the frequently observed star fracture to be one of the manifestations of temper brittleness. He states that, if the fracture strength of a steel is strongly dependent on strain, the tensile stress required to fracture a temper-brittle specimen increases and the stress required to break the specimen transversely decreases as plastic deformation or necking continues. He argues that under certain conditions fracture can occur longitudinally due to circumferential stress arising as a result of necking before the normal transverse tensile fracture can occur. The split type of impact fracture may very well result from a similar mechanism.

Fig. 3 – Fracture of Charpy Impact Specimens

Endurance Properties – The rotating beam fatigue strength of this steel in various conditions, determined using the same type of specimen described in *Metal Progress* in March 1953, is shown in Fig. 5.

The strength reduction ratios for the normalized and for the quenched and tempered conditions are 2.0 and 2.7 respectively. The unnotched endurance limits are approximately 50% of the tensile strength, which is normal expectancy for the particular class of steels to which 81B40 belongs.

Split fractures occur in some of the quenched and

Fig. 4 – Split-Type Fracture in Notched Tensile Specimen of 81B40, Tempered at 900° F.

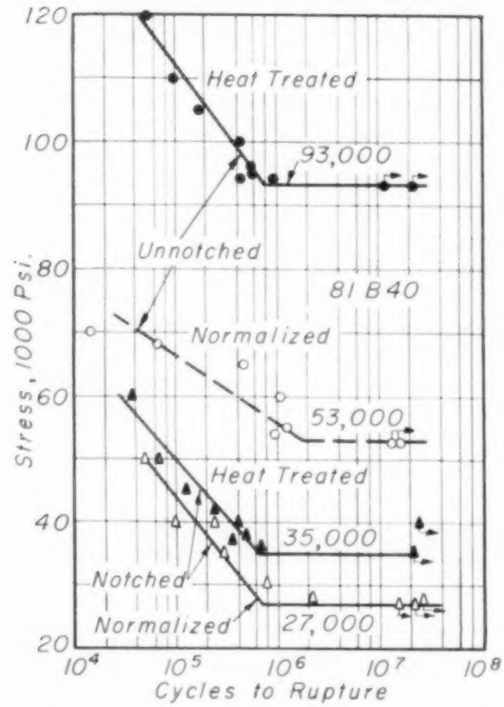


Fig. 5 – Endurance of 81B40 Under Various Conditions. Heat treated specimens were oil quenched from 1550° F. and tempered at 900° F.

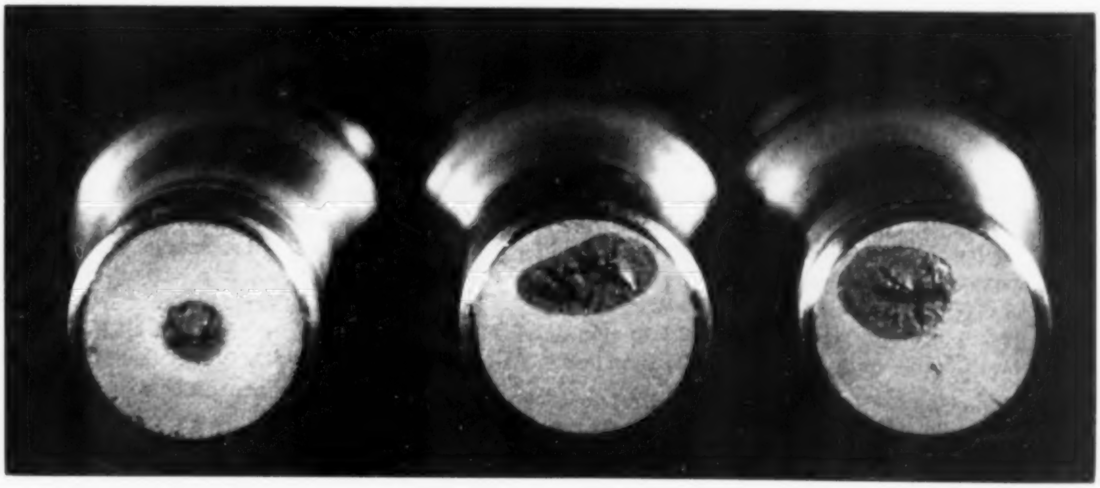
tempered notched fatigue specimens (Fig. 6). Such a split fracture was not observed on the notched fatigue nor on the notched tensile specimens of the other boron-treated steels we have studied in this investigation.

To summarize, the mechanical properties of this heat of 81B40 steel in the quenched and tempered condition as determined by standardized laboratory methods are similar to those of 8740 or 4140 steels of the same hardness level. As is generally found with the boron-treated steels, the properties in the normalized condition are not as good as those of the comparable low-alloy steels without boron. The results also indicate that this steel is somewhat susceptible to temper brittleness. Comparable data for 4140 or 8740 steel are not available and therefore the related susceptibility cannot be determined.

Since the carbon content of this heat is at the extreme top of the specified range and molybdenum about the middle of the range, the hardenability of the heat is high and our results are probably better than could be obtained with heats of average and low chemistries. Although the results so far indicate that the 81B40 composition will probably be a satisfactory substitute for 8740 and 4140 in many applications, final evaluation must be postponed until results of welding tests and the mechanical properties of heats on low-side chemistry are available. Work along this line is currently being done as a cooperative test program conducted by a committee of the Aircraft Industries Association.

Similar metallurgical investigations on steels 86B45 and 80B30 were reported by these same authors in the March 1953 issue of *Metal Progress*, p. 97, under the title "Some Metallurgical Characteristics of Medium-Carbon Boron-Treated Steels".

Fig. 6 – Fractures of Split Type Observed in Notched Fatigue Specimens



By A. E. DURKIN, Thomson Laboratory
General Electric Co., West Lynn, Mass.*

Corrosion Cracking of Martensitic Stainless Steel

WHAT CAUSES 12% chromium stainless steels to fail by cracking? This question has been asked many times when a part has failed in service. An example is the forged turbine blade of Type 403 stainless shown above – note the small cracks along the right edge. These probably could be avoided once the causes of the cracking were understood.

Cracking failures of this steel have often been attributed to stress-corrosion, which occurs when an internal residual stress is present as the result of grinding or other forms of cold work. These stresses may be sufficiently high in themselves to cause cracking failures and are not necessarily associated with corrosive atmospheres. In the light of present information, however, the stress explanation does not appear completely satisfactory.

A more suitable explanation of the cracking failures of martensitic stainless steels which are described here is that they are due to hydrogen embrittlement produced under certain corrosive conditions and not to stress, as such. This embrittlement results from surface corrosion that releases hydrogen which then diffuses into deformed metal structures.

Effect of Stress – A series of tests was conducted wherein sample strips of Type 410 stainless, 0.060 in. thick, 12 in. long, and ½ in. wide, were stressed at various levels and subjected to different corrosive mediums. The stresses were obtained by bending the strips through an arc in a rack fixture which was fixed on one end while the other end was free to be moved to different positions so that various stresses could be obtained at will in the extreme fibers. The stress was calculated from Euler's column formula by determining the deflection at the center. The rack was insulated during test with a "Plastisol" coating.

Stress levels ranged between 30,000 and 150,000 psi. The results of these tests in caustic soda, in cold and boiling concentrated hydrochloric acid, and in a solution of hydrochloric acid and selenium dioxide are shown in Fig. 1. Stresses to cause failure range between 47,000 and 140,000 psi., depending upon the corrosive medium. Two conclusions can be drawn from these curves. First, the "pattern" of hydrogen embrittlement, as described in the literature, is followed completely. Second, the figures for stress are not reliable since processing times in acid are too long.

That these curves follow the embrittlement theory can be seen by analyzing them. The upper line for boiling concentrated HCl shows no breaks; the stock was eaten away too severely. This stock was tested at 140,000 psi. The curve for cold concentrated HCl levels off at a lower stress (74,000 psi.) than the curve for caustic (80,000 psi.) because in the acid there is metal attack while in the caustic hydrogen is evolved with no metal attack; there are, therefore, no stress raisers (irregular-

*The writer wishes to acknowledge the assistance of D. Preston of the Thomson Laboratory and C. Irish and R. Sommers of the Chemical and Metallurgical Program at General Electric Co.

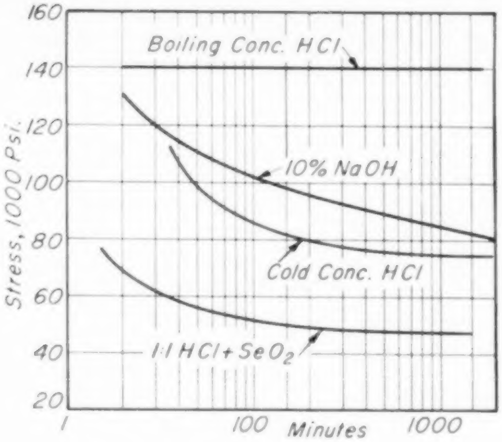


Fig. 1 – Time Versus Bending Stress for 12% Chromium Steel in Various Reagents. Test strip was 12 in. long, 1/2 in. wide, 1/16 in. thick, descaled, and held in a bending fixture during the test

ities in the surface) to expedite failures. The positions of these curves are therefore as expected.

The position of the selenium curve (47,000 psi.) is also as expected.* It has been established that this compound promotes cracking or embrittlement.

A conclusion that may be reached from Fig. 1 is that high stress is required to produce fracture in short time – in at least three strongly corrosive solutions which liberate nascent hydrogen by reaction with the steel. Fracture occurs under lower stress if exposed for longer time; there seems to be a minimum reached, below which the metal would endure stress indefinitely without failure. (These conclusions do not apply to strongly corrosive mediums, such as boiling, concentrated hydrochloric acid, wherein the metal dissolves relatively rapidly.)

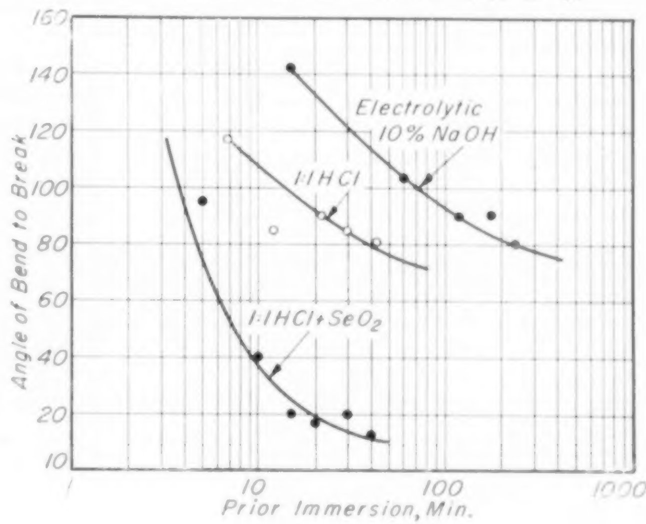
Hydrogen Embrittlement – If the failures were due to hydrogen embrittlement and not stress, the effect on ductility would be reproducible. Therefore, a constant-rate bending fixture was designed similar to that used by Zapffe in his work on hydrogen embrittlement described in *Wire and Wire Products*, May 1947, p. 351. Our specimens were treated either stressed or unstressed and then bent in the fixture around a ⅛-in. pin. The angle of bend to break was recorded.

Bending Stress Experiments

Strips of 12% Cr steel (Type 410) were treated as before and tested in the bend machine; the results are shown in Fig. 2. These samples were unstressed when in the corroding solution. It is apparent that the same type of curve is had in these unstressed samples as in Fig. 1. Since these curves record the influence of hydrogen absorbed in unstressed metal, they give credence to the theory that hydrogen is the effective agent in the stress-life curves shown in Fig. 1.

It is well established that hydrogen can be driven out of a steel by mild heat treatments. If the failures are in any way due to low, steady stress, then little if any recovery in physical properties will be noted after these simple treatments. Also, if the selenium solution is used, it will show that hydrogen embrittlement is a positive factor in the failures; hydrogen here is produced because of metal attack, whereas in the electrolytic caustic solution the hydrogen is artificially produced, in a manner of speaking.

Fig. 2 – Angle of Bend to Break Test Strips Immersed (Unstressed) in Corrodents Noted for Increasing Time. Note similarity to shape of curves in Fig. 1. Prior heat treatment: quenched after 20 min. at 1750° F., drawn 2 hr. at 900° F. Hardness C-44 to 46



Stress Plus Embrittlement – To determine the effect of stress and embrittlement on the

*"Evaluation of Pickling Inhibitors From the Standpoint of Hydrogen Embrittlement", by C. A. Zapffe and M. Haslem. *Wire and Wire Products*, December 1948, p. 1126.

Embrittlement of Stainless

steel, four series of additional tests were run. The results are shown in Table I. Unstressed samples and those stressed to 60,000 psi. were subjected to the acid, and the degree of recovery after remaining in hot water at 200° F. for 1 hr. was determined.

Supposing that the failures are stress failures pure and simple, then they should not be capable of relief. If they are embrittlement failures, then they should be relieved very readily. Comparisons were made by the angles of bend to break. Check values were obtained before the stock was subjected to any corrosive treatment as shown in line 1. The angle of bend to break depends on the original properties of the material.

The second line in Table I gives angle of bend to break for each heat treatment after the test strips were immersed for 20 min. in the 1:1 HCl and SeO_2 solution. Strips were unstressed prior to bending. Comparison of these values with those in the first line shows that the acid treatment has seriously impaired the ductility of the metal.

Line 3 of Table I shows the angle of bend to break when a stress of 60,000 psi. was applied during the acid treatment. (This stress is below the stress previously required to break the strips in a 20-min. immersion period in the acid solution.) The stress during immersion was applied by the rack method as described above, and the samples were then bent in the bending machine to obtain the values shown. A comparison of the prestressed and unstressed samples shows that the stress during immersion had little effect on ductility; approximately the same bend values are obtained for both the unstressed and stressed stock.

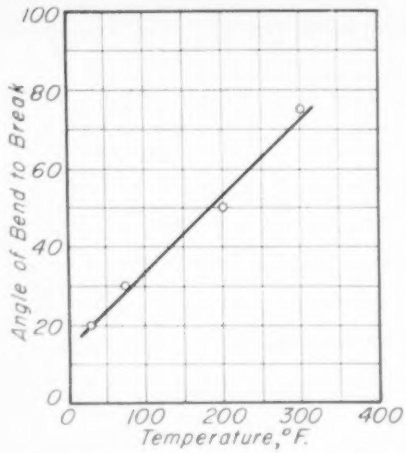


Fig. 3 – Recovery of Embrittled 12% Cr Steel by Aging 1 Hr. at Slightly Elevated Temperature. History of samples: quenched after 20 min. at 1750° F., scale not removed, immersed 20 min. in 1:1 HCl + SeO_2

Lines 4 and 5 show the effect of immersing the acid-treated samples, both stressed and unstressed, in hot water at 200° F. for 1 hr.; it is apparent that ductility is recovered to a marked degree. It should be remembered that the figures in Line 5 illustrate the reaction to the water relief of acid-treated samples stressed at 60,000 psi. during immersion. The results show that all the samples, both stressed and unstressed during exposure, regain their ductility. If these recoveries are not due to a loss in hydrogen, it is difficult to account for the behavior of the samples. It is inconceivable to think that water at 200° F. will relieve internal stress to the degree required to increase the bend ductility so greatly.

Table I – Effect of Tempering on Embrittlement* as Measured by Angle to Fracture

All samples air quenched after 20 min. at 1750° F.

History	Tempering 2 Hr. at			
	None	900° F.	1000° F.	1100° F.
Heat treated only	48	180†	180†	180†
Heat treated; immersed unstressed	17	20	81	98
Heat treated; stressed at 60,000 psi. during immersion	15	18	81	94
As in Line 2; 1 hr. at 200° F. before bending	38	114	180†	180†
As in Line 3; 1 hr. at 200° F. before bending	34	‡	140	180†

*By immersing in 1 : 1 HCl + SeO_2 for 20 min.
†Sample bent flat without fracture
‡No data available

CONCLUSIONS

Two important conclusions can be drawn from these data. First, it is apparent that stress during exposure is a relatively minor factor in reducing ductility. Second, the fact that whatever is affecting the strips can be removed by such a mild water treatment excludes the thought that stress-corrosion could be the principal cause of the failures illustrated in the test strips of Fig. 1 and 2.

The conclusion is that hydrogen embrittlement is responsible. The

discrepancies in total recovery (differences between Lines 4 and 5 and Line 1 in Table I) are attributed to the acid attack. These are not significant.

Relief of Embrittlement – If a hot water treatment will relieve the samples, then heat aging should produce similar results. To check this, additional strips were aged 1 hr. at 32° F. in ice, at room temperature, at 200° F. in hot water, and at 300° F. in a furnace, as plotted in Fig. 3. This was done after the samples were treated for 20 min. in the acid solution. Figure 3 shows that as the temperature is increased the ductility of the samples is improved. It can be assumed from this curve that the point for complete recovery in 1 hr. occurs at some higher temperature. Sims has shown that the hydrogen can be removed from the center of a large cast steel specimen (4 in. square) by aging at 400° F. for 125 hr.* The data above would indicate that it can be removed from strips of 12% chromium steel in relatively short times.

Summary – The cracking of 12% Cr stainless steel is apparently the result of hydrogen embrittlement and not of stress-corrosion as such.

Metals Technology, October 1948, T.P. 2454.

If these cracking failures were the result of stress, the ductility could not be recovered by such a mild and simple treatment as immersion in hot water.

Zapffe's detailed explanation of the theory of embrittlement is pertinent to these materials. What actually causes 12% Cr steels to fail by cracking is most likely the release of atomic hydrogen from moisture in the atmosphere in solution with acid or alkaline dirt and other foreign matter. The molecular hydrogen later formed at deformed areas within the metal causes excessive pressures and the material consequently cracks.

Embrittled steel can be relieved by heating in water or by heating at temperatures up to 500° F. This will prevent cracking. It is important to remember that the susceptibility to future embrittlement is not eliminated by this treatment. Cracking or embrittlement can be prevented only by protecting the steel against corrosion or by heat treating the steel part or structure after fabrication at or above 1000° F. Steel treated in this range shows acceptable resistance to embrittlement.

Industrial Research as a Tool of Industry*

By S. L. HOYT, Technical Advisor, Battelle Memorial Institute, Columbus, Ohio

INDUSTRIAL RESEARCH has become a great national asset and is now the almost universal method for improving existing technology and for putting the findings of science to use.

Research may be defined as an investigational discipline which is pursued to uncover new facts or principles; it is commonly classified as "basic" and "applied". "Industrial" research is principally of the applied type because it has an immediate and practical purpose which someone is more or less patiently waiting to apply. Basic research is commonly pursued for information's sake; seldom is anyone waiting to use the findings, patiently or otherwise. However, industrial research may also avail itself of basic research – a good example is the current work on titanium alloy diagrams. I think we may say that basic re-

*Condensed from the Burgess Memorial Lecture presented before the Washington Chapter, Feb. 9, 1953.

Industrial Vs. Scientific Research

search gives us the seeds which industrial research then plants and nourishes, while industry produces the fruit.

I want to emphasize that industrial research is something new. While science and scientific research grew up together, that is not true of technology and industrial research. For many centuries, technology advanced by clever inventions and by the teachings of experience.

By the turn of this century, this system of technological development had already given us railroads, steamships, electric streetcars, the electric arc and incandescent lamps, electric power, the telephone and telegraph, the phonograph, gasoline and diesel engines, automobiles, farm machinery, machine tools, the bessemer and openhearth processes of steelmaking, and numerous alloys. Nevertheless, many scientific discoveries awaited development and use. Steinmetz was at work on alternating current theory and equipment. Roentgen had discovered his mysterious X-rays and Hertz his curious electromagnetic waves, while Becquerel had discovered natural radioactivity, and the Curies had isolated radium. Numerous rare metals had been isolated as laboratory curiosities and metallurgy had just appeared as a budding science.

The handwriting was on the wall, and here and there enlightened managers saw the need for using science in applying science. As an example, I would like to cite the electrical industry.

I don't know whether the Schenectady laboratory of General Electric Co. was the first full-time industrial research division in this country or not, but it was surely a bold pioneering step, a bare 50 years ago. Its founder, Willis Whitney, is undoubtedly the dean of industrial research directors in our country. However, it was E. W. Rice, Jr., president, and Elbert G. Davis, in charge of the patent division, who had the inspiration to sponsor research on a formal scientific basis. Mr. Rice secured the services of Steinmetz, and Elihu Thomson was brought into the fold by the combination of the Thomson-Houston Electric Co. and the Edison General Electric Co. to form the General Electric Co.

Shortly afterward, F. S. Terry and B. G. Tremaine, recognizing industrial research as an essential part of their business, established the National Electric Lamp Co. Research and development facilities were installed at Nela Park in Cleveland. A small effort went into basic research on light and radiation, but it was to *applied* research that the greatest attention was paid. For this they set up development and testing laboratories and a pilot plant factory. They insisted that these research facilities improve incandescent lamps and the methods for making them. As a result, incandescent lamps have been steadily producing more light for less money.

The chemical industry is also a good example because it has plowed back a higher percentage of its sales into research than have other industries. It was the chemical industry that introduced the first privately operated institute for industrial research. The conception of Robert Kennedy Duncan in 1907, it later became the Mellon Institute for Industrial Research in Pittsburgh. The automobile industry did not lag far behind, possibly because it had the advantage of certain outstanding personalities, such as Henry Ford and C. F. Kettering.

Turning to our own field of metallurgy, a conspicuous expansion occurred in the use of applied or industrial research during the decade which included World War I and the early twenties. As I recall it, this was first noticed in the aluminum, zinc, and nickel-producing industries, with some healthy signs of progress in the precious and rare metals. Not long thereafter similar developments occurred in copper, magnesium, tin, and steel, with cast iron and high alloys coming in shortly before World War II.

The consuming industries, as contrasted with the producing, have been relatively slow in taking advantage of the benefits that come from research. The electrical industry is a consuming industry in metallurgy and it is only fair to say that it showed much less zeal in tackling its consumer problems than it did in developing its own new products. Frequently, the attitude of the consumer is that his supplier will give him the information he needs for fabrication and even for servicing his products. Any company that is large enough to afford research, I believe, makes a grievous error with such a policy.

An example may bring out more clearly what I have in mind. At one time we needed to purchase a large amount of steel sheet for single-coat enameling. The non-reboiling enameling-quality steel such as used for household appliances would have been an obvious answer to our problem. However, the competition in our market was such that we knew we couldn't afford such expensive steel. So we made our own studies of steel behavior in fab-

Courtesy Research Laboratory, United States Steel Corp.

The Consumer's Part

With that kind of pressure, management is faced with increasingly difficult problems of devising the best technology to meet the situation. The recent and current problems of gun barrel erosion, steel cartridge cases, cold extrusion, low-alloy steel armor plate, welded ships, the alternate and boron steels, point up the utility of research today. Even more illuminating is the recent work on jet propulsion, the utilization of nuclear energy, and such materials as the superalloys, titanium and zirconium. It is inconceivable that such new ideas could be developed effectively if we could not apply the methods of industrial research.

The broad question of who should do the research has never been objectively analyzed, to my knowledge. The electrical industry

rication and in enameling, and we were able to tell our suppliers just what we needed. With their intelligent cooperation, we found we could use a cheaper grade of sheet. With large tonnage purchases, the saving paid for a lot of research. We also got a new feeling for the engineer's maxim that "Good enough is best."

This use of industrial research as a guide to intelligent procurement is perhaps less commonly thought of as a function of the research laboratory. Its more common uses for developing new products and processes and for selecting materials and their treatments are too well known to require detailed discussion here.

The Federal Government has been a major factor in advancing technology and hence in promoting industrial research. Numerous agencies are involved and they purchase a wide variety of products, but they have one trait in common – they always want something better. As a naval officer once told me when I plaintively asked him how he thought we were going to make what he wanted, "We just give you the answers; the rest is up to you people."

waited for no one to do the things that needed to be done. On the other hand, the petroleum industry used to waste enormous quantities of natural gas into the air, at a time when that fuel could have been profitably used in our industrial and residential areas. Should it have initiated a research program to find out how to transport that gas economically to market? Or, since it was a transportation problem, should the railroads have undertaken it? Actually, the solution finally came from the pipe industry.

I believe this aspect of industrial research deserves more attention now than it has received in the past. Where the interest of a using company or industry is greater than that of the supplier, the former might well undertake research from which it stands to gain. That is especially true today because there are university and private research institutes which can supply the facilities needed for practically every branch of technology.

It is now appropriate to take a look at industrial research against the backdrop of history. Up until the introduction of industrial research,

there were three periods when man reached new heights in intellectual output.

First was the period of the early prophets of the Old Testament, the Greek philosophers, and the craftsmen and engineers of Rome. The accomplishments of the latter were limited to engineering structures such as roads, buildings, temples, ships, aqueducts, and certain engines of warfare. Beyond the intellectual triumphs and moral teachings of that age, those fields that concerned material welfare were left to the engineers and artificers and were handled by the empirical method.

The next period was the late Renaissance. It was then that the physical sciences got their start with the experimentation of Galileo in mechanics and the work of Copernicus and Newton on the movements of celestial bodies. Thus, at a relatively early period, science, at least, was off to a sound start in both methodology and philosophic guidance, but technology continued to proceed in its ancient and empirical groove.

The third period began about the middle of the 18th century when the industrial revolution was ushered in with Watt's steam engine. Civil engineering became an independent profession, and the development of the physical sciences spread from physics to chemistry and then to thermodynamics and physical chemistry, mechanics, electricity, and finally to metallurgy. With this concatenation of scientific and technological development, it was inevitable that the methods of the former should be used for improving the latter.

In my example of the electrical industry the start came about 1900. Curiously enough, in metallurgy, a start can be detected at an earlier date if we accept the use of controlled experimentation by industry as our criterion. As examples, I would cite the work of Hadfield in England, and Sauveur, Taylor and White in this country, and of Tschernoff on critical points and the heat treatment of guns in Russia.

Hadfield developed his silicon and manganese steels during the 1880's. Sauveur correlated laboratory work on structure with steel characteristics and technical practice, demonstrating the utility of controlled experimentation in industrial work. This same method was used by Taylor and White in their early work to develop the analyses and heat treatments for high speed steel.

We may assume that the end of this period came when science assumed the leading role in technology, both in development and practice. The transition was not abrupt, but empiricism gradually faded out and was replaced by the scientific method. The end of this transition period is usually thought to have come at about 1940. I am judging largely by two criteria.

In 1940 the clouds of war were gathering and our government had a large procurement program under way. Not only did this call for development work, but the government also sponsored research programs on a large scale. This activity, by bringing in new organizations and training new research workers, demonstrated the possibilities of the research method on a sufficiently large scale to have a nationwide effect.

My second criterion comes from our experience at Battelle which indicated a swing in that direction at about the same time. Research was in the air in industrial circles. Management seemed to change from the attitude of "Should we spend company money on such a speculative venture as research?" to the modern approach, "What research program best suits my company's needs?". Industrial research had come of age.

RESEARCH A NATIONAL RESOURCE

This historical discussion will have brought out, I trust, the long apprenticeship served by technologists in their constant endeavor to improve their arts and crafts. The evolution was slow and labored; because it was wrought by the empirical method, it was relatively costly and inefficient. Ultimately, and I believe inevitably, the strong hand of management replaced empiricism with the tool of industrial research.

I have not cited statistics nor have I tried to describe the methods and philosophy of industrial research. However, I don't believe it is beside the point to say that industrial research is a great national resource and one of the most significant factors in the strength of our country. It has brought prosperity to the nation and material comforts to its citizens. It feeds strength and versatility into the industrial machine and out of it come more and better employment for the workers, better living conditions, more time for recreation and, in brief, a better life for all of us.

To the scientists who give us facts and principles and to the research workers who translate them into industrial operations, we should be very generous in our recognition.

Continuous Short-Cycle Anneal for Spheroidization of Cartridge-Case Steel

By O. E. CULLEN, Chief Metallurgist
Surface Combustion Corp., Toledo, Ohio

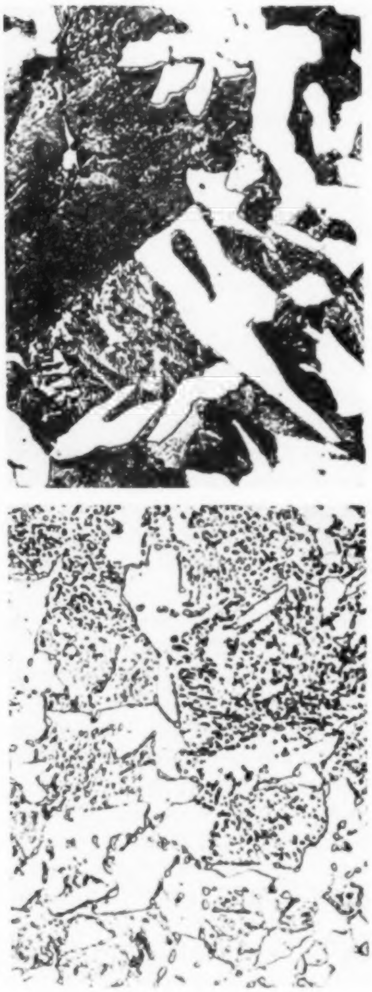


Fig. 1 – A.I.S.I. 1030 Steel Before and After Spheroidization. Top – hot rolled and pickled plate. Bottom – after annealing in batch-type cover furnace through a 168-hr. cycle. 500×

Because of the severe forming operations encountered in steel cartridge-case manufacture, an appropriate annealing treatment for A.I.S.I. 1030 steel is required to develop a suitable microstructure. With the possible exception of certain hot upsetting methods, some degree of spheroidization of the steel is required, and for most operations spheroidization should be substantially complete. In view of the recognized reluctance of 1030 steel to spheroidize, the time-temperature cycles for volume production have been quite long, and heat treating capacity has been heavily taxed.

Generally, 1030 steel has been spheroidized by stacking hot rolled and pickled plates in large annealing covers and subjecting them to heat treating cycles of 80 to 170 hr., depending on the size of the load and on the degree of spheroidization required. Typical examples of 1030 steel plates before and after a long spheroidizing treatment in annealing cover are shown in Fig. 1.

When cartridge-case steel is annealed in covers, the plates may be as large as 12 ft. long by 6 ft. wide and are usually shipped in this form to the cartridge-case manufacturer for punching out the circular blanks. The spheroidized scrap must be returned to the steel mill for remelting and this scrap represents an appreciable waste of heat treating capacity.

In the interest of increased furnace capacity as well as a better control of the degree of spheroidization, other methods of annealing have been investigated. After rather extensive laboratory tests, the process chosen by us at Surface Combustion Corp. was to spheroidize the steel blanks themselves, thus confining the scrap for remelting to the remainder of the hot rolled as-received steel from which the blanks were taken.

The heat treatment of cartridge-case blanks lends

itself particularly well to the use of continuous furnaces, which also offer advantages for control of time-temperature cycles. Continuous operation assures a steady flow of production and thus eliminates the necessity for stockpiling hot rolled and spheroidized materials.

The elements of spheroidization of hypo-eutectoid steels are well known and need no general review. However, it might be pointed out that heterogeneous austenitization and rapid cooling to just below the critical range appear to be necessary if heat treating time is to be held to a minimum. (By "heterogeneous austenitization" is meant the conversion of the pearlitic patches into austenite of approximately eutectoid composition, without heating the steel much above the critical point, and thus preventing much, if any, diffusion of carbon into those portions of the structure which were previously carbon-free ferrite.)

Theoretically at least, spheroidization of hypo-eutectoid steel can be done rapidly by heating just above the Ac_1 point, quenching to just below the Ar_1 point and holding at this latter temperature for enough time for cementite to nucleate and grow. Where the physical dimensions of the work, the tonnage to be heat treated, or the constancy of chemical analysis of the steel do not lend themselves to this abbreviated treatment, it becomes necessary to utilize the most efficient heating and cooling cycles possible and to establish an austenitizing temperature and a final subcritical spheroidizing temperature which are adequate over the range of chemical analysis which may be encountered in the steel.

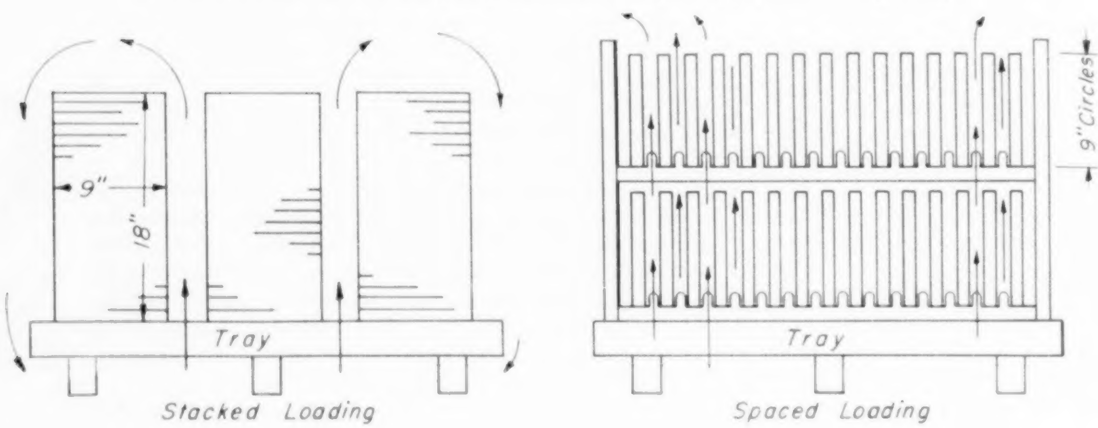
In developing a continuous process for spheroidizing, there is a decided advantage in treating the cut blank rather than the entire plate. When the work is arranged so that minimum cross sections are heated and cooled, the time lost in these transitional steps or in waiting for equalization of temperature is minimized, and the total time can be more fully utilized for those portions of the annealing cycle which are directly responsible for the quality of the finished product. In addition, the benefits of spaced loading over stack loading from the standpoint of heat transfer are shown in Fig. 2.

ADVANTAGES OF CONTINUOUS PROCESS

The advantages accruing from accelerated but controlled heating and cooling in a continuous spheroidizing process are twofold. Of importance, of course, is the short heating and cooling time. More important is the opportunity to take full advantage of thermo-physical characteristics of the 1030 steel which cause a hysteresis gap or lag between the Ac_1 temperature and the Ar_1 temperature, as the steel transforms on heating or cooling. For example, during slow heating of 1030 steel, the lower critical temperature (Ac_1) is approximately 1340° F., whereas the lower critical temperature during slow cooling (Ar_1) is approximately 1250° F. Here is a lag of 90° F. Using continuous heating furnaces,[1] this delayed transformation can be utilized so that final and complete spheroidization of carbide particles of optimum size can occur at higher than usual temperatures and at greatly accelerated rates.

In preliminary experimentation, it was as-

Fig. 2 – Methods of Loading Steel Cartridge-Case Blanks in Continuous Annealing Furnace. Arrows indicate heat flow for stacked loading at left; spaced loading at right



sumed that a heterogeneous structure was desirable – that is, patches of spheroidized carbides interspersed between sizable ferrite crystals – but with a better carbon distribution than is usually found in hot rolled steel. For these reasons an austenitizing temperature of 1380° F. was chosen. The 1030 steel was of normal cartridge-case quality.

When this steel was austenitized at 1380° F. and cooled to 1255° F. in 3 hr., the carbide particles were still too small to show at 500 diameters (Fig. 3, left). Further cooling to 1235° F. at the extremely slow rate of 2.5° F. per hr. – or a total of 8 hr. additional – followed by water quenching showed that transformation of austenite had occurred but the resulting structure was still quite strongly pearlitic (Fig. 3, center). For comparative purposes a duplicate sample was isothermally annealed by austenitizing at 1380° F., transferring to a salt bath at 1235° F. and holding at that temperature for 10 hr. (Fig. 3, right). The mixed structure of pearlite and spheroidite was not substantially different from the structure shown in the center micro, which had been furnace treated for approximately the same number of hours.

These structures could be improved by materially extending the time for transformation of pearlite into spheroidite, and this is quite common practice in processes now in use. In the development of a continuous spheroidizing

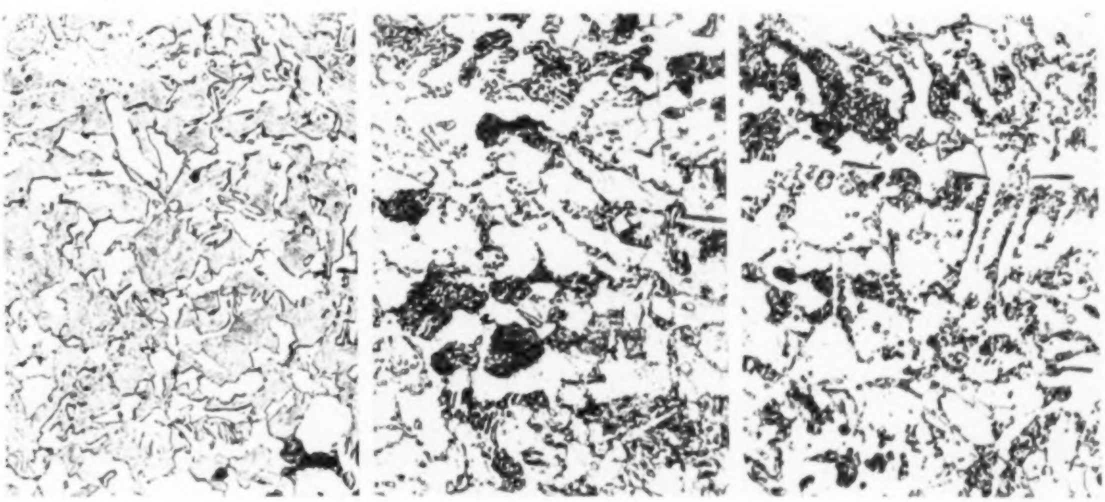
A Practical Compromise

process it was not necessary to increase transformation time – in fact, a much higher degree of spheroidization occurred in shorter holding times, with the result that a continuous production method has been made practical.

COMPLETE SPHEROIDIZATION

Figure 4 shows a spheroidized structure produced by a time-temperature cycle for a continuous furnace, which will turn out approximately 17,500 lb. per hr. of cartridge-case blanks. The time-temperature cycle shown in the lower portion of Fig. 5 takes advantage of relatively fast heating and cooling in the continuous furnace to cool the steel below the Ar_1 point and then reheat to slightly below the Ac_1 point, where spheroidization is aided by increased temperature. If one might speculate, he might say that in the short time for equalization at 1240° F. – just below Ar_1 – a multitude of carbide particles are nucleated. If the steel were held at this temperature such particles would grow, but growth would be very slow. Growth occurs at increasing rates as the temperature is higher, as long as the temperature is below Ac_1 – that is to say, as long as the carbide is inherently insoluble in the iron. In other words, we have given the steel the best conditions for a rapid rate of

Fig. 3 – Structure of 1030 Steel After Various Treatments. Left – heated to 1380° F., cooled to 1255° F. in 3 hr. and water quenched. Structure consists of austenite (now martensite) and ferrite. Center – same treatment except an additional 8 hr. for cooling to 1235° F. (at 2.5° F. per hr.); water quenched. Structure is predominantly pearlite and ferrite with some spheroidite. Right – heated to 1380° F., transferred to salt bath at 1235° F. and held at constant temperature for 10 hr. Structure consists of pearlite, spheroidite and ferrite. 500 ×



Design of the Furnace

carbide precipitation and grain growth, and an optimum number of nucleating centers on which the particles can grow.

The design of a suitable continuous spheroidizing furnace presented many interesting problems. Figure 5 shows a furnace which includes all the features necessary for spheroidizing 1030 steel by this short-cycle process. As shown in the drawing, radiant tubes, circulating fans, baffle walls and forced-air cooling tubes are provided to insure equalization of temperature throughout the work, and to minimize the time required for heating and cooling during the over-all cycle. The furnace is designed for controlled atmospheres, which may be of the exothermic type to prevent oxidation of the steel or of the endothermic type for carbon control. While the furnace shown is arranged for producing cartridge-case steel in the fully spheroidized condition at the rate of 17,500 lb. per hr. on a 19½-hr.

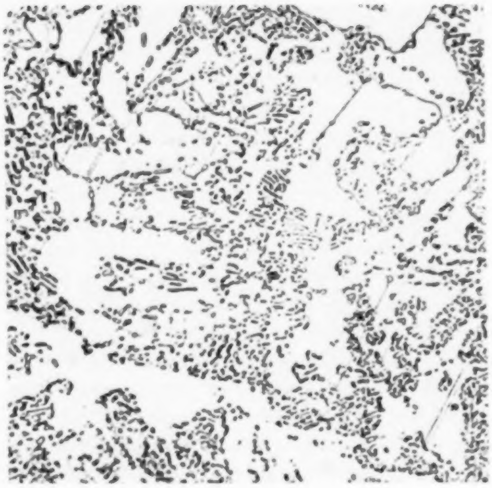


Fig. 4 – Spheroidization Is Substantially Complete After Annealing in Continuous Furnace for Short Cycle Shown in Fig. 5. 500 ×. Pearlite patches are austenitized just above Ac_1, carbide nuclei formed just below Ar_1, and spheroids grow rapidly just below Ac_1

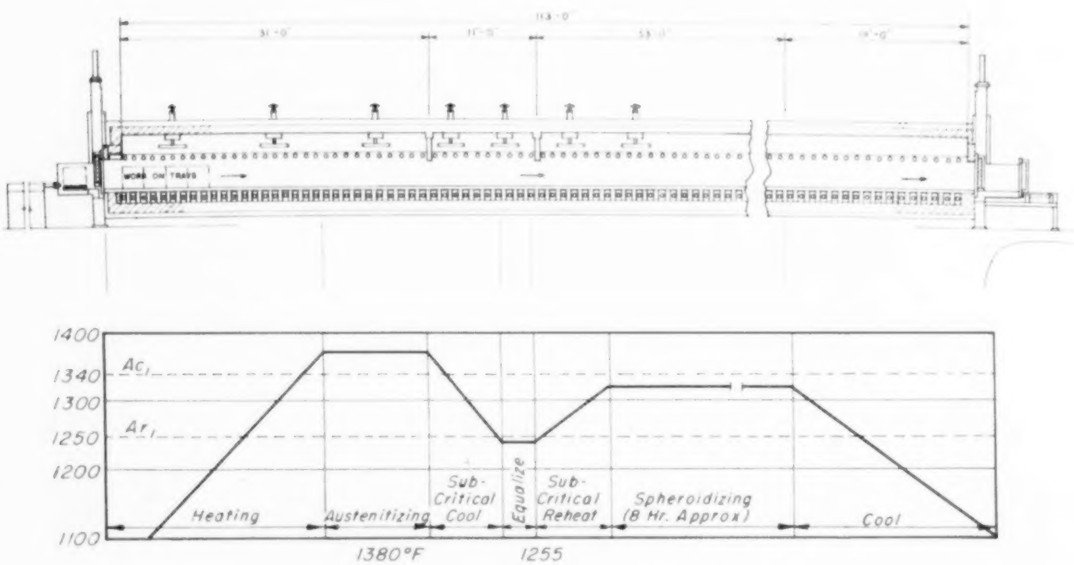


Fig. 5 – Cross Section of Furnace for Continuous Short-Cycle Spheroidizing Anneal of A.I.S.I. 1030 Steel. Time-temperature curve below

total cycle, the incorporation of additional baffle walls between furnace zones permits different time-temperature cycles as desired. One furnace now under construction has been designed to produce steel which will be spheroidized to different degrees on total time cycles of 15½ to 19½ hr., with production varying from 22,000 to 17,500 lb. per hr. Such adaptability provides a most useful continuous heat treating tool for annealing any one type of steel, with varying degrees of spheroidization, or for annealing a number of different types of steels, each on its own most efficient time-temperature cycle.

By JOHN PARINA, JR.
Associate Editor, Metal Progress

Fig. 1 – Spray-Painting of Automobile Bodies at De Soto Is Speeded by Special Hangers From Overhead Conveyer Which Permit Body to Be Swung on Horizontal Axis. Spray booths are ventilated by filtered air brought through ceiling

Trends in Better Finishes for Automobiles

WHAT IS BEING done to mitigate the corrosion of automobile components, such as bodies, bumpers, exterior trim, exhaust mufflers and tailpipes? Surely, an ever-present and, in those regions where slippery winter streets and roads are salted, a costly problem. Also, what attention has the automotive industry paid to some of the coatings which have stirred interest among finishing people in other industries? These questions were put to those people at Chrysler Corp. and General Motors Corp. who are most intimately concerned.

The answers ranged from strong conviction down to the diplomatic "iffy" kind that are characteristic of engineers when proof is lacking. Engineers at General Motors are positive they have a practical solution for increasing the life of exhaust mufflers and tailpipes with their aluminum coating process; management at De Soto states that the finishes and finishing techniques now in use there appreciably increase the life of automobile bodies and of the finish itself; corrosion resistance of trim, however, needs to be improved through the use of a substitute finish equal in quality to that of nickel and chromium formerly used for these items. A considerable amount of effort is being devoted to this end at Chrysler, and since some of the possible substitutes are still in the investigatory stage, tentative conclusions only – heavily qualified, of course – are available.

In due fairness to the group that phrased the latter kind, it should be stated that their qualified answers could instead have very easily been a terse "no comment". The complexity of their problem can be indicated by reviewing briefly some of the requirements a satisfactory substitute for bright nickel plating must meet: Provide a coating having good protective ability and good corrosion resistance; produce a deposit having good brightness and adherence and adequate ductility; be acceptable for chromium plating; be used with a bath that has some leveling action and is easy to control. It would be highly desirable also that the substitute process be adaptable for use in existing plating equipment.

RECENTLY PUBLICIZED ELECTROPLATES

Since the issuance of N.P.A. Orders M-14 and M-80 (which prohibit the use of nickel in noncritical applications other than automobile bumpers), bright white brass, tin bronze, and tin-nickel alloy plates have been studied. The most promising (a word used with qualifications by Donald M. Bigge, supervisor of Chrysler's Materials Testing Laboratories) of these is the tin-nickel alloy plate, the process for which was developed at the Tin Research Institute of England.

Tin-Nickel – The tin and nickel are simultaneously deposited in about equal atomic proportions from an electrolyte containing stannous chloride, nickel chloride, sodium fluoride and ammonium bifluoride. The resulting alloy plate is an intermetallic compound having relatively high hardness; the uniformity of thickness and of composition in the deposit is excellent.

Tin-Nickel Plates for Automobiles

This alloy, containing about 67% tin and 33% nickel by weight, gives good corrosion resistance, even without a subsequent chromium coating. Because only about one third as much nickel is deposited as in the bright nickel plate of equal thickness, heavier coatings of tin-nickel could be deposited to provide additional corrosion resistance. Its shortcomings at present are its brittleness and need for mechanical polishing to obtain the desired brightness, and the fact that its use would be limited to those applications where nickel is now permitted. Furthermore, this deposit has a faint rose-pink color which, in automotive applications, would have to be masked by an over-plate of chromium in order to satisfy buyer preference.

Of the many factors which influence the acceptability of a substitute finish for bumpers and trim, or "bright work" as it is sometimes called, that of buyer preference is constantly kept in mind by the plating engineers at Chrysler Corp. For years now, the buying public has accepted chromium plate as a standard from the standpoint of appearance. Consequently there is no alternative – unless the buyers were re-educated, as the promotion people put it – but to give them chromium, or a finish that has the brightness and appearance (including the bluish cast) of chromium. So chromium is used as the final coating, even though some of the bare "substitute" plates give adequate resistance to corrosion without it. In fact, the tin-nickel alloy plate has been reported to be more resistant to tarnishing in atmospheres polluted with SO_2 and H_2S than electrodeposited chromium, and, with an undercoating of copper to minimize corrosion at pores, can be used as a decorative coating in outdoor applications.

Bright White Brass – The bright white brass, an alloy of about 80% zinc and 20% copper, was of great interest to the automotive industry about a year ago when copper was short. For a time it was actively investigated as a possible substitute for copper plus bright nickel. The color of this finish, its brightness-building action, and its good ability to take on a plate of chromium are its principal advantages. (This process was described by W. B. Knight in "White Brass Plating – One Solution to the Nickel Freeze", published in *Metal Progress* for March 1952.)

On the debit side are its brittleness and, on outdoor exposure, its tendency to form a considerable amount of white corrosion products. An overlay of chromium plate seems to accelerate formation of red rust on the underlying steel (pore rusting). (Also, some investigators – *not at Chrysler* – report that an undercoat of flash copper on steel may blister the white brass.) White brass of various compositions was studied, these containing 10, 20%, as well as 30% copper. Studies are now being made of white brass containing 40% copper. White brass, however, is considered at Chrysler as the least likely substitute for bright nickel.

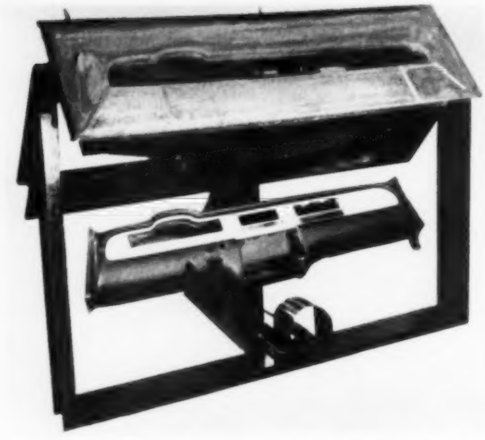


Fig. 2 – Spray-Decorating of 175 Dash Panels per Hr. Is Being Accomplished on 1953 Models in the Plants of a Prominent Automotive Manufacturer. Painting is done at a transfer station on the conveyer line, thus combining the transfer handling and the painting operations. Electroformed metal masks, air-operated fixtures, and mask-washing machines are employed. The mask-holding fixture gives a tight pressure-seal between work and mask, which assures a cleanly painted line. Inset in the photo of the fixture is an illustration of the painted part. Courtesy Conforming Matrix Corp., Toledo, Ohio

Tin-Copper Alloy – The tin bronze is an alloy of 10% tin and 90% copper ("Nickelex"). Chief difficulty with this is that uniform, bright deposits cannot be obtained consistently; however, the Nickelex finish is easy to chromium plate. Although this alloy (or, more accurately, intermetallic compound) withstands indoor tarnishing, it lacks the corrosion resistance necessary for outdoor exposure.

Tin-Zinc – Another plating considered but not actively investigated is the 20% tin and 80% zinc alloy. This plate has good corrosion resistance, but is not suitable as an undercoat for chromium because full-bright deposits of the tin-zinc are difficult to obtain, and also because the subsequent chromium deposit has a gray appearance which cannot be buffed to

brightness using moderate pressure, while heavier pressure develops sufficient frictional heat to melt the underlying tin-zinc alloy.

Other Systems – Bright zinc deposits, even with a chromium plate and a baked clear lacquer, are not suitable for outdoor applications. They have been used in the appliance field and to some extent for interior trim in automobiles.

Chromium plating over copper (that is, without the intermediate nickel coat) is quite satisfactory on inside parts without the use of any lacquer or clear enamel and has been used for several years. The objections to this system for outdoor use are the inadequate resistance of the lacquers to mechanical abrasion and to car washing and polishing compounds, and the fact that when the lacquer finally fails, the corrosion of copper through the chromium produces dark stains.

Whether any of these would replace the standard nickel-chromium or copper-nickel-chromium for finishing bumpers, or the straight chromium steel (Type 430, with chromium on the high side at 17%) plus chromium flash which is now being used for exterior trim, the engineers would not speculate.

Both of the present methods have their drawbacks: the former because thinner deposits of nickel must be used; the latter because of higher fabricating costs, and, in some instances, higher initial costs of the straight chromium. The higher fabricating costs – based on comparison with those for Type 302 stainless formerly used – result from the slightly greater difficulty in working this alloy, and in finishing it to obtain a good surface, since the chromium plate will not smooth out scratches and other minor irregularities.

In addition to these considerations is the relatively poor resistance to salt corrosion possessed by current methods of protection – which are being used only because of the nickel shortage. A good example of this kind of failure was brought into sharp focus two winters ago in Detroit following a heavy snowstorm. At that time enough salt was used on a stretch of main highway during the two days of the storm that the quantity averaged close to 100 lb. of salt for each car traveling over this stretch. (This year, however, Detroit had practically no snow.) Comparable conditions exist in most large northern cities, and conditions along the seacoasts are hardly less severe in this respect. Add up the effect of such corrosive exposure over the years the average owner keeps his car, then the best of protective plates in use are not good enough. Despite the fact that the work of the plating engineers has just begun, there is fair indication that progress is being made to find plated coatings with improved corrosion resistance.

Aldip – About a year ago, General Motors Corp. announced an aluminum dipping process designed to give ferrous metals a protective coating against corrosion and oxidation. Conceived originally to protect army tank heat exchangers from exhaust gas condensates, the coating is now being considered for other uses involving corrosion, such as the center tubes of exhaust mufflers, tailpipes, and even for certain jet engine components which operate up to 1550° F. Service life data for the heat exchangers made of S.A.E. 1010 and coated with aluminum by this process show they are equal to units formerly made of Type 321 stainless steel.

The "Aldip" process was invented by D. K. Hanink and H. L. Grange, and guided by A. L. Boegehold, assistant to the general manager of research laboratories, and C. J. Tobin, all ASMembers. It uses a salt bath or flux capable of absorbing aluminum oxide and iron oxide, and molten aluminum; both are contained in a single pot, with the molten salt floating on the aluminum. (Individual furnaces can be used for the salt and aluminum.) A unique feature of this bath is the use of non-molten salt as a barrier between the bath proper and the ceramic lining of the pot. Composition of the bath, as disclosed in the letters patent, is 47% potassium chloride, 35% sodium chloride, 12% cryolite, and 6% aluminum fluoride, and its operating temperature is normally between 1300 and 1325° F. The items are ready for coating after their removal from a fluxing and preheat bath.

Routine of this process, as followed at the General Motors' Harrison Radiator Div., Lockport, N. Y., where the heat exchangers are coated, is as follows: Clean in alkaline dip, wash in hot water, clean in acid pickle if steel is rusted, rinse in cold and hot water, and dry in furnace. Next, the exchangers get a 4-min. treatment ranging from 1280 to 1400° F. in the preheat bath, are transferred to the aluminum bath for a 30-sec. immersion, then returned to the preheat and fluxing bath for removal of excess aluminum.

The structure of the Aldip coating consists of two layers, an outer layer of aluminum and a subsurface layer of aluminum-iron compound.

Enameling Auto Bodies

A diffusion heat treatment at 1775° F. or higher for periods of time varying from 1 to 4 hr., depending on the length of time for the aluminum dip, alters the as-dipped coating into a relatively uniform phase of aluminum-iron solid solution. This heat treatment is necessary to prevent spalling and cracking of the hard surface layer under conditions of cyclic thermal shock.

Automobile exhaust mufflers and tailpipes, aluminum coated internally and externally, have, in test applications, outlasted by several times their counterparts of uncoated steel. The satisfactory results obtained from the performance tests, as well as the relatively trouble-free operation of the bath over the past 5 years, indicates that the Aldip process can be adapted to production-line methods.

Although the use of this aluminum coating on jet engine components is still being studied by the General Motors' Allison Division, Indianapolis, the information gathered to date indicates that S.A.E. 4130 having a protective coating of Aldip will give satisfactory service up to 1550° F. after the coating is diffusion treated, provided the strength of the section is satisfactory when 4130 is used. Incidentally, the Germans ten years ago used aluminum-plated steel instead of highly alloyed steels for some jet engine components that did not require hot strength or high resistance to creep.

ORGANIC FINISHES

The finishing of auto bodies as practiced by the De Soto Division, Chrysler Corp., takes advantage of some of the wealth of knowledge available on the use of organic finishes for decorative and protective purposes. First, the bodies are cleaned with a Chrysler specification alkaline cleaner containing a proprietary emulsion, rinsed with hot water, given a zinc-iron phosphate coating, rinsed with warm water, and then are given a final rinse with a weak chromic acid solution to improve the rustproofing characteristics of the phosphate treatment as well as to improve the enamel adhesion. The bodies are then dried in an oven. After the joints have again been "glazed", or sealed, with an air-setting plastic compound, the bodies receive a double coat of primer. This is applied wet-on-wet, the second coat being sprayed on about 3 min. after the first, and baked at 350° F. for about 20 min.

Then follow wet sanding (320-grit paper), moisture-dry at 350° F., sealing of joints, spraying of the underside of the body and interior of trunk compartment with a mastic compound to obtain sound-deadening, cleaning, and a coat of sealer "enamel"* to the interior as well as exterior surfaces. The enamel is baked for 20 min. at 350° F., again water-sanded and oven-dried at 350° F., and then sponged with V.M.P. (a solvent-type cleaner) to remove finger marks and any grime which might be present. As soon as the cleaning solvent has evaporated, the exterior surfaces are thoroughly vacuum cleaned and are finally ready for the finish coats. Here, as with the primer, the enamel is sprayed wet-on-wet, the second coat following the first after about 5 min. A slightly lower temperature, 250° F., compensated for by the longer drying of 30 min., is used to bake the final coats as a precaution against the possibility of discoloration caused by overheating.

Enamel used at De Soto is of the alkyd type, as is the primer. The function of the latter is for filling and, since it contains corrosion-inhibiting pigments, it aids the protection imparted by the zinc phosphate coating. The undercoat, the first coat of enamel used, assists the finish coat in acquiring the required opacity.

One of the most important elements in producing a flawless finish is the provision for good ventilation in the spray booths and baking ovens. The air used in these locations at the De Soto plant is double filtered to remove dust.

Strong preference for the enamel finish over the lacquer type is expressed at De Soto, this being on the basis that the former has better stability to the effects of sunlight and holds a high gloss for a longer time. The other properties (low film permeability, continuity, adhesion, cohesion, and chemical inertness) are considered to be of equal value for the two types. However, an important consideration in obtaining full protection afforded by the film's low permeability is the elimination of the small pockets and recesses at joints in which water might collect, so all exposed joints are filled or covered with the plastic filler.

*Enamel, as defined by H. H. Uhlig in the "Corrosion Handbook", is a pigmented varnish, in its strictest sense (a varnish being a combination of drying oil and fortifying resin, either natural or synthetic). The wide use of fortifying resins in oil-base paints has resulted in the disappearance of any distinction other than an arbitrary one between paints and enamels. The term lacquer, on the other hand, is currently used to designate any air-drying or baking type of clear composition, usually, but not necessarily, based on nitrocellulose or similar cellulose resins.

Critical Points

by the Editor

New Ferro-Alloys and Alloying Metals

Responded with some gratification to an invitation to attend an "editorial preview" of Electro Metallurgical Co.'s new plant at Marietta, Ohio, because this company – as well as all the other divisions of the parent Union Carbide and Carbon Corp. – has traditionally been quite reticent about its manufacturing methods. This plant has somewhat larger capacity than any of Electromet's other establishments, notably those at Niagara Falls, Ashtabula, Ohio, and Alloy, W. Va. Furthermore – being of most modern construction – it has included all the desirable features of materials handling, labor-saving, safety devices and quality control which have been developed by the company throughout the last 50 years. Such large supplementary capacity makes it evident that this firm, at least, believes that alloy and stainless steels are here to stay – in fact, will continue to grow in relative importance at about the same rate as they have since 1940.

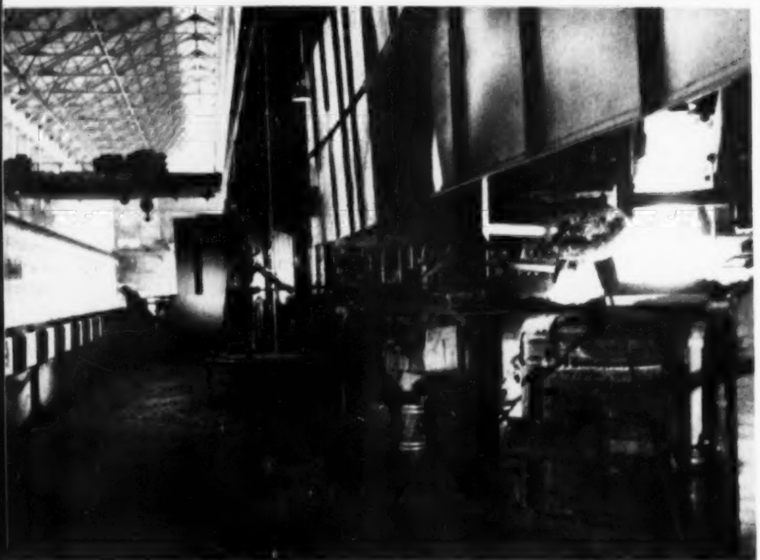
Historic Marietta, the first settlement in the Northwest Territory, was chosen as a site for three reasons – unlimited coal and water, adequate barge transportation for raw materials and short rail haul to principal markets, and good labor supply drawn from a rather dense agricultural population. (Electro Metallurgical Co.'s experience at its other plants is that five interviews are necessary to select one employee; at Marietta two out of three qualified.) So a 200,000-kw. steam plant was erected for necessary power. Steam from the four turbines, by the way, is also taken to an adjoining chemical plant, there to furnish heat for converting benzol from Pittsburgh's byproduct coke ovens to phenol, an important raw material for Bakelite phenolic plastics, made by another U.C.C. division.

What might be called the conventional part of the alloy plant are three large buildings containing 14 three-phase electric furnaces for making ferro-alloys. These are squat circular shells, with electrodes deeply submerged in the charge, which is spouted down at intervals from bins far overhead. Charge is ore, coal and coke for reducing agent, flux, and steel turnings; molten ferro-alloy and slag are tapped at intervals into flat chills. Much effort has been expended on dust and fume control, so successfully that an elaborate crushing, screening and packaging plant for sizing the furnace product operates in an atmosphere as clear as an ordinary machine shop. These furnaces produce ferrochromium, ferrosilicon, ferromanganese and silicomanganese of various standard analyses, other than low-carbon types.

Extra-low-carbon ferrochromium is made in one part of what might be called the unconventional part of the Marietta alloy plant. Likewise, the product is so unconventional it has been called by a new name, "Simplex ferrochrome", and the staff is bubbling over with enthusiasm about its brilliant prospects. It starts with a fairly high-carbon ferro-alloy which is ground in some of the largest ball mills you ever did see to a fine flour, pug-milled with some equally fine-ground quartzite and a little organic binder, pelletized into "artificial oysters" by dimpled rolls, and dried. Next the pellets are spread on the refractory bed of a flat car and the car run into a huge vacuum furnace. Heating, reaction temperatures, pressures and all operations for eight such furnaces are controlled from a central room. Chemical changes are "solid-state" reactions between the carbon and silica particles, forming carbon monoxide and silicon. The result is a pellet ("Simplex ferrochrome") containing as little as 0.01% max. carbon, about 5% silicon and 10% excess unchanged SiO_2. The latter two items are not detrimental – quite the contrary, for experience in tonnage plants indicates that they enable the melter to make steels of all sorts (not alone the extra-low-carbon types) by single-slag rather than double-slag practice, thus saving up to 2 hr. furnace time on each heat.

In simplified terms, the new practice would include these steps: Melting the solid scrap, blowing down the carbon and oxidizing the bath with oxygen, adding and melting the porous Simplex alloy in small batches, skimming slag, pouring the metal. Any necessary amount of chromium can thus be rapidly added to the bath without bringing the carbon back up; the silicon deoxidizes the bath and the solid silica particles furnish nuclei whereon the molecular SiO_2 (from refining reactions) attaches and quickly rises to the surface.

Two other equally unconventional depart-



View on the Charging Floor of One of the Furnace Buildings at Electro Metallurgical Co.'s New Alloy Plant in Marietta, Ohio

ments are a-building, one for electrolytic chromium metal, the other for electrolytic manganese metal. The market for chromium will be principally in the manufacture of high-chromium, low-iron alloys for heat resistance. Manganese metal will serve to replace some of the nickel in austenitic chromium-nickel steels (18-8, 25-20 and the like), thus freeing the nickel for use in engineering alloy steels and in high-nickel alloys so important to the defense effort.

For both these departments the preliminary refining of the ore will be in the arc furnaces. The ground-up ferro-alloys will then be dissolved in appropriate solutions, the solutions purified and electrolyzed in diaphragm cells. The chromium solutions, for example, are so corrosive that cells, launders, piping and like equipment for handling both anolyte and catholyte are of polyethylene plastic reinforced with fiber glass. Cathodes are stripped from the starting sheets when the deposit has grown to about $\frac{3}{16}$ in. thick.

Observations at Lindberg, Chicago

Come to think of it, it is not too illogical that the pioneer commercial heat treating shops were established near toolsteel warehouses. At least that happened in Chicago; maybe the magnet that drew them together is still operating, for Lindberg Steel Treating Co. is building in the rapidly growing Melrose Park industrial suburb where a couple of fine steelmakers already have erected some slick new warehouses.

Roy Lindberg, president, has promised *Metal Progress* an article about this commodious new plant, but it is not amiss to say now that each department – annealing, tool hardening, carburizing or whatever – will be self-contained, even to dimensional correction, cleaning, inspection and, where feasible, packaging for shipment. Ample adjuncts, such as offices, laboratory, cafeteria, rest rooms, are included in the main building. Tankage, coolers, and pumps for quenching solutions are in a separate building. It will have under one roof double the total capacity of Lindberg's present six buildings, thus being able to absorb the additional work which may be predicted in the region from a study of its productivity during the last two decades. Manufacturers have never hesitated to send their really hard jobs or special work to the commercial heat treater; some are finding that costs on routine work are enough lower to warrant transporting the parts to and fro. It would not surprise me to find someday that the astute manager – who does not hesitate to call in an outside specialist to equip and run his cafeteria and canteens – will do the same with his heat treat.

While admiring a barrel-shaped furnace with a long tubular entrance lock and a much longer water-cooled exit, bright annealing a stream of small stainless steel parts in cracked ammonia atmosphere, was told by Edward Pavesic, director of research for Lindberg Steel Treating Co., that bright annealed austenitic stainless had once or twice shown a superficial skin hardness. It was most puzzling because the microstructure was unchanged to the very surface. So we got to discussing the cause of hardness and agreed that fundamentally it is due to "irregularities" in the crystalline lattice and associated "internal strain". (Quotation marks are used to indicate that giving an observation a name does not mean we have got very far toward a fundamental reason.) It is a handy fact that a useful amount of strain can be induced in iron by alloying it with a little carbon, and the additional phases are easily seen under the microscope. Neither

carbon nor microscopic visibility of strained areas is necessary – witness the age hardened aluminum alloys. Disorganized situations *very* close to each other, however, are necessary. Could it be that 18-8, bright annealed in cracked ammonia, during certain heat treating cycles, had absorbed (and later rejected) enough hydrogen or nitrogen to leave the austenitic crystals in a sufficiently disorganized condition to induce a considerable amount of hardness (slip resistance)?

Such a hardening treatment – by evanescent gas – might even add useful surface hardness to quenched and tempered steels. It might act by causing a myriad of vacancies – places in the lattice where the expected atom is missing. Vacancies can induce a degree of hardness and strength. They can even be accumulated into microscopically visible cavities of geometric shape by proper "annealing", as has been proved by Robert J. Gray, ⊕, in a beautiful series of micrographs made at Oak Ridge National Laboratory.

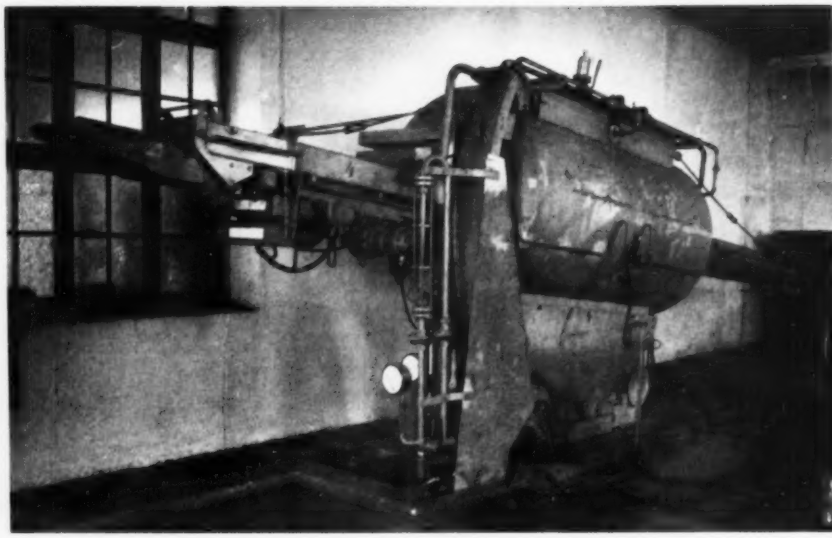
Lindberg Engineering Co. also produces factory-made furnaces (adv.) – the kind that are completely erected and lined before shipment, although when sectionalized such construction can be pretty big. Cary Stevenson, vice-president for sales, and Fred Hansen, vice-president for manufacturing, both long-time ASMembers, were full of ideas about present opportunities and future possibilities. Hansen was particularly proud of a department in which equipment may be "mass-produced" at the rate of two units a day. This department may operate for a month on, say, Cyclone annealing furnaces or gas preparation units. Operations are subdivided so a squad of men in eight hours can assemble and weld the frame; another squad in another place puts in the brick lining in their day; at the third station the gadgetry is affixed; at the fourth the unit is painted and inspected. Comes night with the movers, who take away the two finished units, transfer partially built ones to the next station, and bring in material for the next day's work. "After the second or third day, there's no time out looking at blueprints," says Hansen.

A most interesting adjunct is a department for research in ceramics, complete with a full-sized through-type kiln. Its primary function is to study special refractory formulations to meet the demands of modern heat treating. "For example," Stevenson said, "certain prepared atmospheres operating at high temperatures and high concentrations are responsible for severe damage – not to the hottest brick but to the cooler ones backing up the lining. These insulating brick must be almost chemically free of iron or other compounds which will throw down carbon from the hot gases penetrating to them. We can insist on such special requirements from our own crew; it is far more difficult and time-consuming to get them from a refractories manufacturer, and we would have to buy such large lots that our inventories would be huge. So we make our own, as we need them." Two small items are in quantity production. One is a byproduct – porous ceramic cups for gasoline filters, now standard equipment on good automobiles. The other is needed in Lindberg's new analytical train for rapid and simultaneous analysis of steel for carbon and sulphur, in the form of a small cupel for fusing the sample; obviously it must be *free* of carbon and sulphur.

Powder Metals

How would you organize an educational course for such an ⊕ chapter as at Oak Ridge, where 90% of the members are Ph.D.'s and local option bans anything stronger than light beer? The Editor attended one of these meetings early in the spring, addressed by Henry H. Hausner ⊕, manager of atomic energy engineering for Sylvania Electric Products Inc. Hausner told of his trip to Europe last summer; in addition to his comments already printed in *Metal Progress* for November 1952, he said he was greatly attracted by the advantages, both in minimizing losses of protective atmosphere and in expediting the transfer of product, of through-type sintering furnaces mounted on trunnions which could be tilted one way when charging and the other way when discharging. An item which impressed him because it revealed new properties of old materials (like the remarkable compacts made of slightly oxidized aluminum powder) was the manufacture of electric resistors of molybdenum powder whose particles had been previously coated with disilicide. Such rods may operate *in air* up to 3100° F. (1700° C.), but next one must learn how to make them with a less unmanageable degree of fragility. He mentioned also the interesting possibilities of multiple-layer sheet made of almost any combination of metals. Even conventional bimetals, like stainless steel on iron, can possess ultra-fine

grain (if it is desirable) when fabricated by a succession of light passes and intermediate anneals below the recrystallization temperature. After some erudite remarks on the theory of sintering and atomic diffusion, he was asked if he could state any generalization relating the sintering temperature of a metal to its melting point, and the meeting returned to ground level with his answer, "It is usually lower."



Powder Metal Sintering Furnace at Metallwerk Plansee, Reutte, Austria

The Editor has often thought that the periodical literature on powder metals and fabrication of parts therefrom assays very low in engineering fact. It was therefore refreshing to listen to a description of manufacturing methods at National Cash Register Co. given to a recent meeting of the Metal Powder Assoc. by W. J. Doelker and H. T. Harrison. Details of shop practice at their plant vary with the size and shape of the part, but may be indicated by the following data for small parts ¼ in. thick: Commercial electrolytic iron powder plus ½% zinc stearate for lubricant is pressed at 90,000 psi. After sintering 45 min. at 2070° F., the density is 7.3 g. per cc. (solid iron is 7.87) and the parts are free from intercommunicating porosity. When gas carburized at 1550° F. for 2.5 hr., oil quenched and tempered at 800° F., the tensile strength is 65,000 psi., elongation 3%, and impact 75 ft-lb. per sq.in. Some 90 small and intricate parts are now in production at National Cash Register – 700,000 per week. Scrap is about 0.5%, mostly from breakage in the green state. Size uniformity is so good that inspection costs are 'way down. The carbide dies never wear out; one has produced 9,000,000 parts with less than 0.0002 in. wear. Surface smoothness is 8 to 15 micro-inches – on the order of a ground finish.

Now we're getting somewhere!

Book Review

Advanced Metallurgy

BY J. B. AUSTIN*

ACTA METALLURGICA; *Bimonthly Journal for the Science of Metals. Bruce Chalmers, Editor. Publication Office: 57 East 55th St., New York City 22. Subscription $6.00 per year to members of American Society for Metals*

INCREASING SPECIALIZATION in science and engineering has led rather generally to the formation of smaller and more homogeneous groupings within each field. For example, the broad field of metallurgy has become divided into smaller areas, such as extractive metallurgy or physical metallurgy. This sort of thing happens so often that it is hardly news. What is news, because it happens much less frequently, is the emergence of a new grouping from the interaction of several well-established sciences. It is therefore worthy of note that in recent years a community of interest among chemists, physicists and metallurgists engaged in studying certain character-

*J. B. Austin is director of research for United States Steel Corp., Kearny, N. J.

istics of the solid state has given rise to what is conveniently, if somewhat vaguely, termed "The Science of Metals".

Workers in this field have been handicapped, however, by the lack of a focal point for publication. There has been no suitable forum for presenting pertinent papers which, in consequence, have been scattered widely over the whole vast literature of science. Through the efforts of a group led by John Hollomon of General Electric's research laboratories and John Chipman of Massachusetts Institute of Technology's metallurgical faculty, and with financial support by the , this need has now been filled by the establishment of a new bimonthly journal edited by Bruce Chalmers, formerly professor, department of metallurgical engineering, University of Toronto, and now Gordon McKay professor of metallurgy at Harvard. It is called *Acta Metallurgica*, an International Journal of the Science of Metals.

The basic policy of this new periodical is described in the first issue (January 1953) in a statement by Cyril S. Smith, chairman of its Board of Governors, which reads in part:

"A new journal . . . . . . should create a new grouping of readers; it should serve as a medium of expression for a new combination of authors, and it should serve as a focus for the integration of types of knowledge the relation of which is newly perceived. *Acta Metallurgica* will deal with the whole science of metals; it will draw upon the basic sciences of physics and chemistry on the one hand, and upon the sciences to be inferred from metallurgical practice on the other, with considerable dipping into other applied sciences and the characteristics of other materials where these will assist the understanding of metals.

"This journal cannot constitute the whole professional reading of a metallurgist or other scientist concerned with metals; indeed, it will have failed if it does, for its purpose is to break down, rather than to encourage, specialization."

Although to date the American Society for Metals is the only society making a direct financial contribution, 17 other technical societies, representing most of the free world, are cooperating in this venture. If there ever was an international journal, this is certainly it! It undertakes to print papers in whatever language they may be submitted, although it is almost certain that most will be in English, and each article is accompanied by summaries in English, French and German. In the first two issues there are 13 papers from the United

States, 13 from the United Kingdom, and one each from Holland and France.

These papers cover a wide range of metals – iron, aluminum, copper, uranium, tantalum, zinc and columbium. They include discussions of the mechanism of formation of martensite, of twinning in various metals under various conditions, of heat of activation, of energy storage during cold working, of surface energy, of dislocations, and of internal friction. They cover both theoretical and experimental work. Some are highly mathematical; all are, as would be expected, advanced. Few, if any, of them will be of direct interest to a practical heat treater. Yet they are the seed corn which will provide a harvest for him five or perhaps ten years from now. Some of these seeds will, so far as he is concerned, inevitably fall on stony ground, but others will mature to yield results of direct practical value. Good, sound, basic data always become useful and one can be certain that before long the information recorded in this journal will be put to use by an increasing number of "practical" members of the American Society for Metals.

The journal carries letters to the editor, book reviews, and, as a somewhat unusual feature, it lists papers in the field of the science of metals which appear in a number of other periodicals, especially those of cooperating societies. The double-column format is pleasing in appearance and easy to read, and the reproduction of photomicrographs is good.

Light Metallurgy

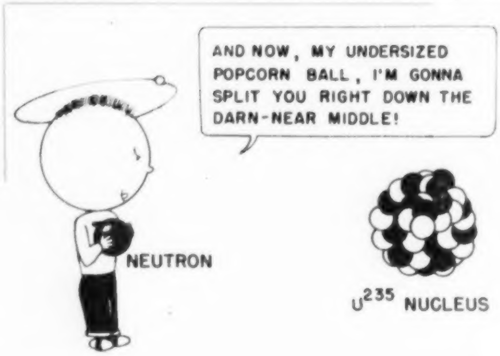
The Building of a Nuclear Reactor

By B. A. Rogers, Institute for Atomic Research and Ames Laboratory, Iowa State College (With an assist by Tom McEnergy as drawn by Carl Ver Steeg)

In the back-of-an-envelope stage, the planning of a nuclear reactor is not especially difficult. It becomes still easier if one has the assistance of an expert like Tom McEnergy. Tom is always glad to lend a hand; any metallurgist should be grateful for his help.

Okum Dokum, Doc. Ol' Tom McEnergy will take over.

To get down to fundamentals, the basic event in a nuclear reactor is the breaking up of nuclei of U^{235} atoms – that is to say, uranium atoms having a weight of 235 on the atomic scale. Of course, an atom of uranium has an electronic cloud surrounding its nucleus just as other atoms do, but these clouds are unimportant in the operation of the reactor and may be forgotten.



And now, my undersized popcorn ball, I'm gonna split you right down the middle!

The nucleus of a uranium atom, U^{235}, is composed of 235 little particles huddled together. Ninety-two of the particles are positively charged protons and 143 are neutrons without charge. (A proton is identical with the nucleus of a hydrogen atom, and a neutron has nearly the same mass as a proton.) This uranium nucleus of 235 particles can be broken up if struck by a slowly moving neutron that happens to be roving about, originating – say – from a cosmic ray.

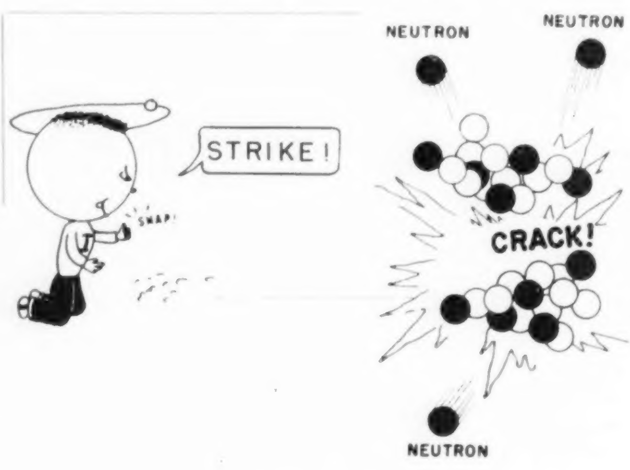
Strike!

When a neutron of the right speed strikes a U^{235} nucleus, four things happen:

1. The nucleus splits into two unequal parts that fly in opposite directions at high speed.
2. Two or three neutrons get lost from the main pieces and start out independently.
3. A lot of energy is released as heat.
4. Gamma rays and other forms of radioactivity are produced.

To put the matter briefly, the impact of the neutron causes fissioning of the U^{235} nucleus.

The neutrons which originate in the fission and start out independently must cause the fissioning of at least one more U^{235} nucleus if the so-called "chain reaction" in a block of uranium is to continue. They will not do so if they escape from the piece of uranium,



which they are very likely to do, since a neutron is so small in comparison with the distance between atom centers (nuclei) in the solid metal. If the neutron were as large as a ping-pong ball, the nucleus to the same scale would be as large as a basketball, and the distance between adjacent nuclei would be over two miles. Hence, if it happens to start in the right direction, a newly released neutron may race down the wide corridor between rows of nuclei and escape from the uranium entirely.

Not only may neutrons escape from the piece of uranium, but they may be captured by the nuclei of U^{238} atoms. Mention of capture by a nucleus of U^{238} brings up the point that ordinary uranium is composed of two kinds of uranium atoms: those with 92 protons and 143 neutrons and those with 92 protons and 146 neutrons — in other words, U^{235} and U^{238}.

Hm . . m . . m. This is a weighty problem. They're chemically alike, but they don't weigh the same . . . . ???

This matter of capture by the heavier "isotope", U^{238}, is the more important because there are so many of them in uranium in comparison to the U^{235} variety. There are no less than 140 U^{238} nuclei for every U^{235} nucleus. These two kinds of nuclei behave quite differently when struck by a neutron.

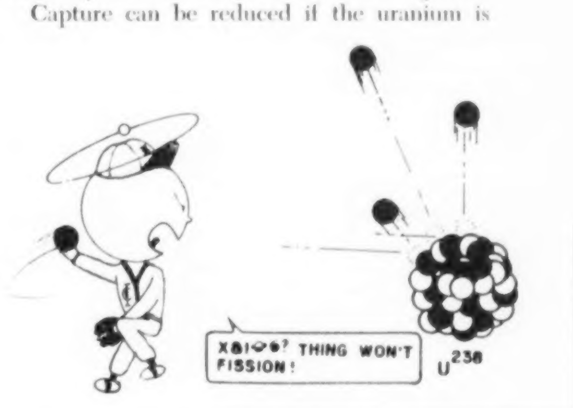
If a neutron that has been liberated during fission of a U^{235} nucleus immediately strikes another U^{235} nucleus, it is slowed somewhat by the encounter but only jolts the heavy nucleus a bit. However, if it has collided with so many nuclei that its speed has been reduced from an original value of about 30,000,000 miles per hr. to about 5000, it will cause fissioning of any U^{235} nucleus it may then happen to hit.

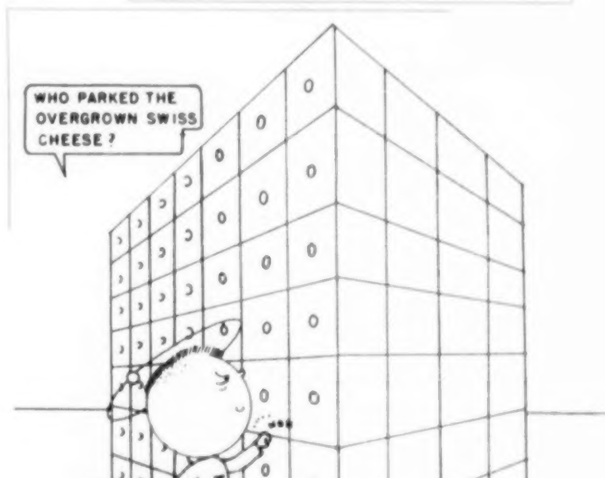
X&!!---! thing won't fission!

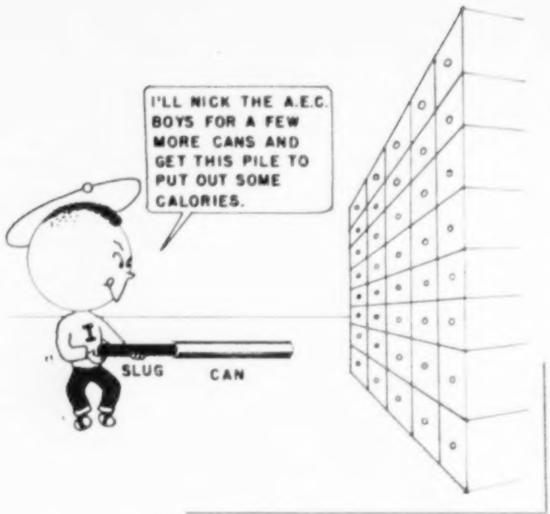
If moving at high speed, a neutron bounces off a U^{238} nucleus much as it would from one of U^{235}. However, if it has been slowed by successive collisions to an intermediate speed of 10,000 to 100,000 miles per hr., it is likely to stick to a nucleus of U^{238}. Thus, that particular neutron is lost for producing fissions of U^{235}. The U^{238} nucleus has become a U^{239} nucleus.

Loss of neutrons by escape would be reduced if the piece of uranium were made larger, but selection of the best size of lump to support a chain reaction requires also consideration of another problem: How can the neutrons be slowed to the proper speed for fissioning U^{235} nuclei without being captured by U^{238} nuclei at intermediate speeds?

Capture can be reduced if the uranium is







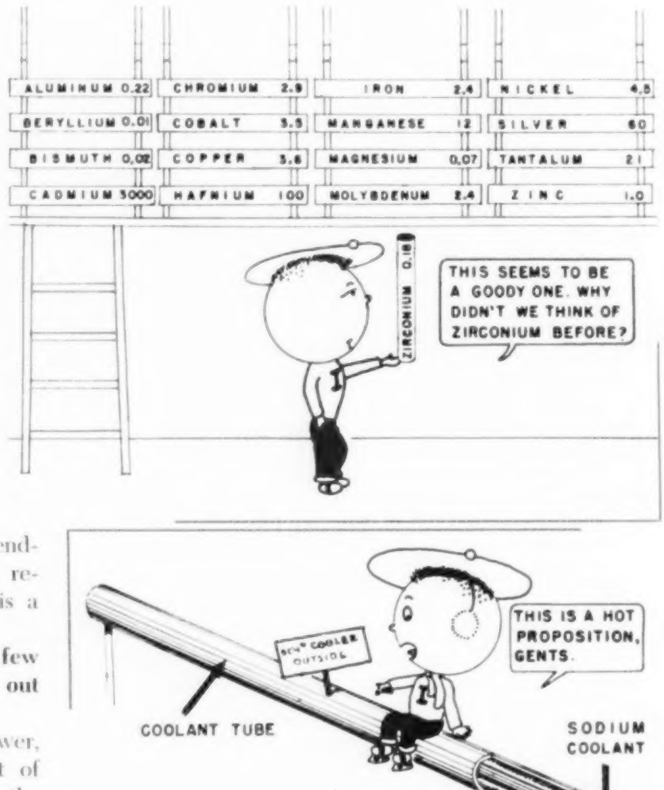
in small slugs so the neutrons can escape into some surrounding substance that does not capture them. In this substance, they will be slowed down by successive collisions with the nuclei of its atoms. Some neutrons will drift back into the original slug of uranium (or another slug in the vicinity).

Who parked the overgrown Swiss cheese?

Practically, this scheme works if the uranium slugs are inserted into holes bored in graphite blocks that have been assembled into a roughly cubic "pile". (This is known as the reactor core.) Graphite carbon is chosen because nuclei have almost no tendency to capture neutrons but do reduce their speed; hence, carbon is a satisfactory "moderator".

I'll nick the A.E.C. boys for a few more cans and get this pile to put out some calories.

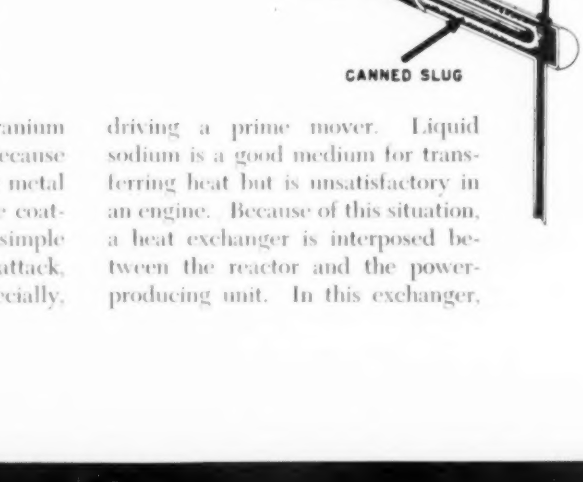
If the reactor is to furnish power, the heat developed as the result of fission must be transferred out of the reactor core to some form of engine. A high rate of heat transfer can be obtained if some appropriate liquid is circulated in the space between the uranium slug and the surrounding graphite. Because uranium is not resistant to corrosion, the metal slugs must be provided with a protective coating. The selection of the coating is not simple because the metal must be resistant to attack, strong at elevated temperatures and, especially, must not capture neutrons. The last requirement eliminates many useful metals; for example, stainless steel captures about 15 times as many neutrons as aluminum.



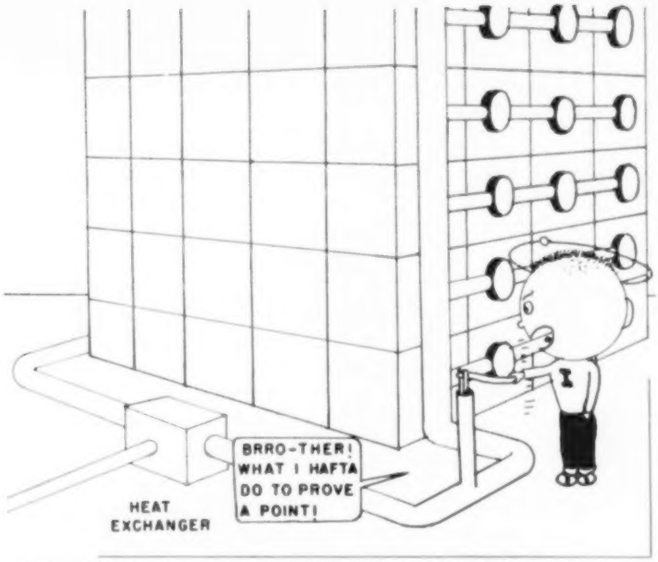
This seems to be a goody one. Why didn't we think of zirconium before?

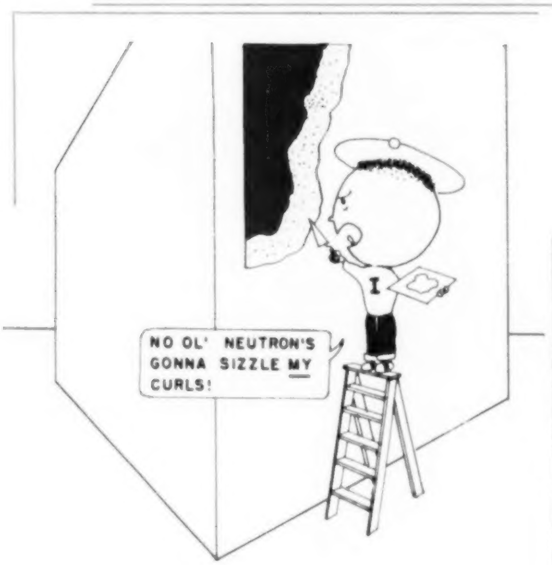
For heavy-duty uses, such as would be required of a reactor for driving a battleship, the field of acceptable metals dwindles to a very few possibilities, of which one of the best is zirconium. Approximately the same specifications apply to the tubes that lie inside the graphite blocks through which heat transfer liquid circulates.

This is a hot proposition, gents.



A liquid that is suitable for transferring heat away from a reactor may not be good for driving a prime mover. Liquid sodium is a good medium for transferring heat but is unsatisfactory in an engine. Because of this situation, a heat exchanger is interposed between the reactor and the power-producing unit. In this exchanger,





the hot liquid from the reactor heats the steam or other vapor that operates the engine. This arrangement also has the advantage that any radioactivity in the liquid circulating through the reactor does not get into the engine.

Bro-ther! What I hafta do to prove a point!

Some thought must be given to the neutrons that escape from the graphite blocks (moderator) because they have an unhealthy effect on people. Also, other radiations, particularly gamma rays, must be blocked.

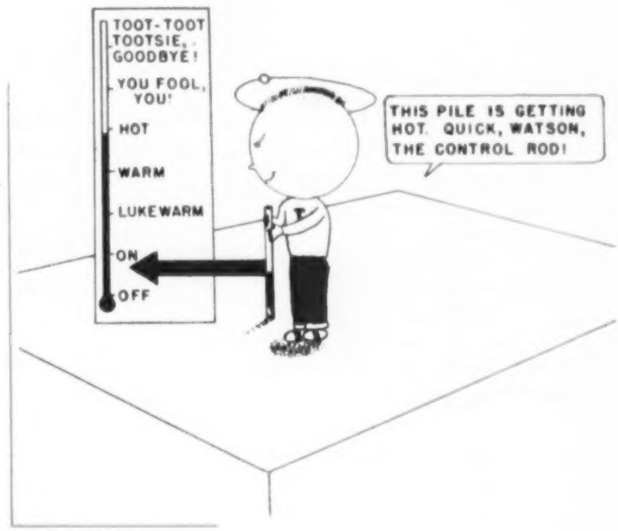
No ol' neutron's gonna sizzle MY curls!

Satisfactory protection is provided by a composite envelope of several inches of steel and several feet of concrete. Although such a shield is suitable for a stationary reactor where ample space is available, some weight-saving modification is essential for submarine and aircraft reactors.

This pile is getting hot. Quick, Watson, the control rod!

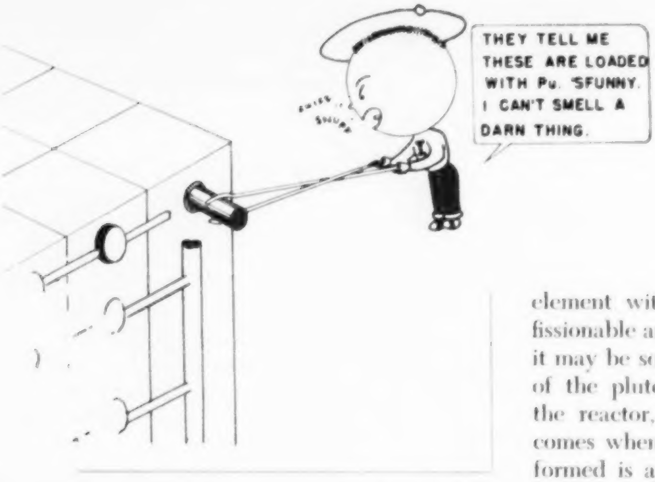
Fissioning may proceed so rapidly as to produce more heat than is needed. It may even cause a rise in temperature sufficient to damage the reactor. Accordingly a device for automatically controlling the rate of fissioning is an essential part of the reactor.*

A useful controller is one that thrusts some neutron-capturing substance farther into the reactor if the rate of production of neutrons (and the temperature) increases beyond the desired operating level. Correspondingly, if the production of neutrons becomes too low, the device withdraws the substance from the core so that it will capture fewer neutrons and leave more available for fissioning. The neutron-capturing substance may be a block of boron or cadmium, or something



*Not mentioned yet is the origin of the first neutron, or neutrons, that start the reactor. Free neutrons are produced in all substances, including the atmosphere, by the cosmic rays that continuously bombard the earth. Furthermore, a reactor has a built-in source of neutrons because uranium atoms fission spontaneously at a very slow rate. Hence a few neutrons are always in the vicinity ready to start a reaction. If one lacked confidence in nature, he could introduce some beryllium and polonium into the reactor; when beryllium is struck by alpha rays coming from polonium, it gives off neutrons.

One might also imagine that uranium ores could constitute a natural nuclear reactor but the conditions seem never to be correct for the starting of such a reaction.



containing considerable amounts of such elements. Either element will absorb more than a thousand times as many neutrons as an equal volume of aluminum or zirconium.

In case the automatic control mechanism should fail, a manually controlled apparatus for capturing neutrons may be thrust into the reactor. This can be made of a rod tipped with a block of cadmium or boron and is so simple that it can scarcely fail.

They tell me these are loaded with Pu. 'Sfunny. I can't smell a darn thing.

Not even a nuclear reactor will run indefinitely. One reason for loss of efficiency arises from the two large fragments that are formed by every fission. These remain inside the uranium slugs and after some radioactive convulsions settle down as the nuclei of atoms of some lighter element. In effect, the uranium becomes alloyed with elements formed from the destruction of its own atoms. Some of these elements have high capacities for capturing neutrons; after they have accumulated in quantity, they cut seriously into the number of neutrons available for the chain reaction – fissioning more U^{235} nuclei. Consequently, the uranium slugs must be removed from the reactor after a period of operation and put through a refining process for extraction of these contaminating elements.

Even if extraction of the alloy constituents were not necessary, removal and treatment of the slugs after a period of operation would be advantageous. The reason therefore goes back to the capture of neutrons by U^{238} nuclei. Each U^{239} nucleus formed by this capture eventually rejects an electron (beta particle) to become a neptunium nucleus. In time, each neptunium nucleus ejects another electron to become a plutonium* nucleus, Pu^{239}.

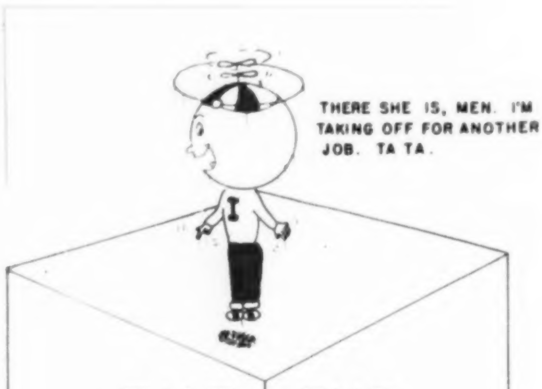
Besides being a radioactive element with a very long life, plutonium is fissionable and makes excellent bombs. Hence, it may be sold for military use. Because some of the plutonium formed is also fissioned in the reactor, just as U^{235} is fissioned, a time comes when a high proportion of the amount formed is again lost by fissioning. A slug in which this condition is developing should be taken out so that its plutonium can be extracted and a fresh slug put in its place.

There she is, men. I'm taking off for another job. Ta, ta.

*Since each neptunium and each plutonium nucleus is surrounded by its cloud of electrons, atoms of these two elements are present in the uranium as alloying elements.

Mobile Blast Furnaces?

"He specializes in designing, engineering and erecting mobile installations, such as lift bridges, ore and rock crushers, blast furnaces, bulk material handling equipment – anything that moves." (Quotation from *Cleveland Plain Dealer* Pictorial Magazine.)



What problems face you...

Ni-Resist provides a ready solution

because

No other cast metal offers such a unique combination of useful engineering properties

Use Ni-Resist® for a specific need or a combination of requirements.

Mechanically Similar to Gray Iron, and resembling austenitic stainless steel in many characteristics, Ni-Resist can solve these problems at moderate cost...

Ni-Resist has good resistance to corrosive attacks of acids, alkalies and salts. In 5% sulfuric acid, for example, NI-RESIST outlasts cast iron 100 to 1.

Work-Hardening Characteristics combined with thorough graphite distribution make NI-RESIST ideal for metal-to-metal wear service.

Ni-Resist of normal hardness machines like 200 BHN gray iron and is readily weldable.

Ni-Resist shows up to 10 times better scaling resistance, and up to 12 times better growth resistance than plain iron at temperatures up to 1500° F.

Ni-Resist has high specific electrical resistance (140 micro ohms/cm^3).

Thermal Expansion may be controlled from 60% higher than that of plain iron to a low approaching that of Invar.

Several Types of Ni-Resist are available to meet a variety of industrial demands.

At the present time, nickel is available for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling.

INCO

The International Nickel Company, Inc.
Dept. 20, 67 Wall Street, New York 5, N. Y.
Please send me booklets entitled, "Engineering Properties and Applications of Ni-Resist," and, "Buyers' Guide for Ni-Resist Castings."

Name .... Title ....
Company ....
Address ....
City .... State ....

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

Standard Ferrite Grain Sizes for Low-Carbon Steels
(0.20% Carbon or Less)

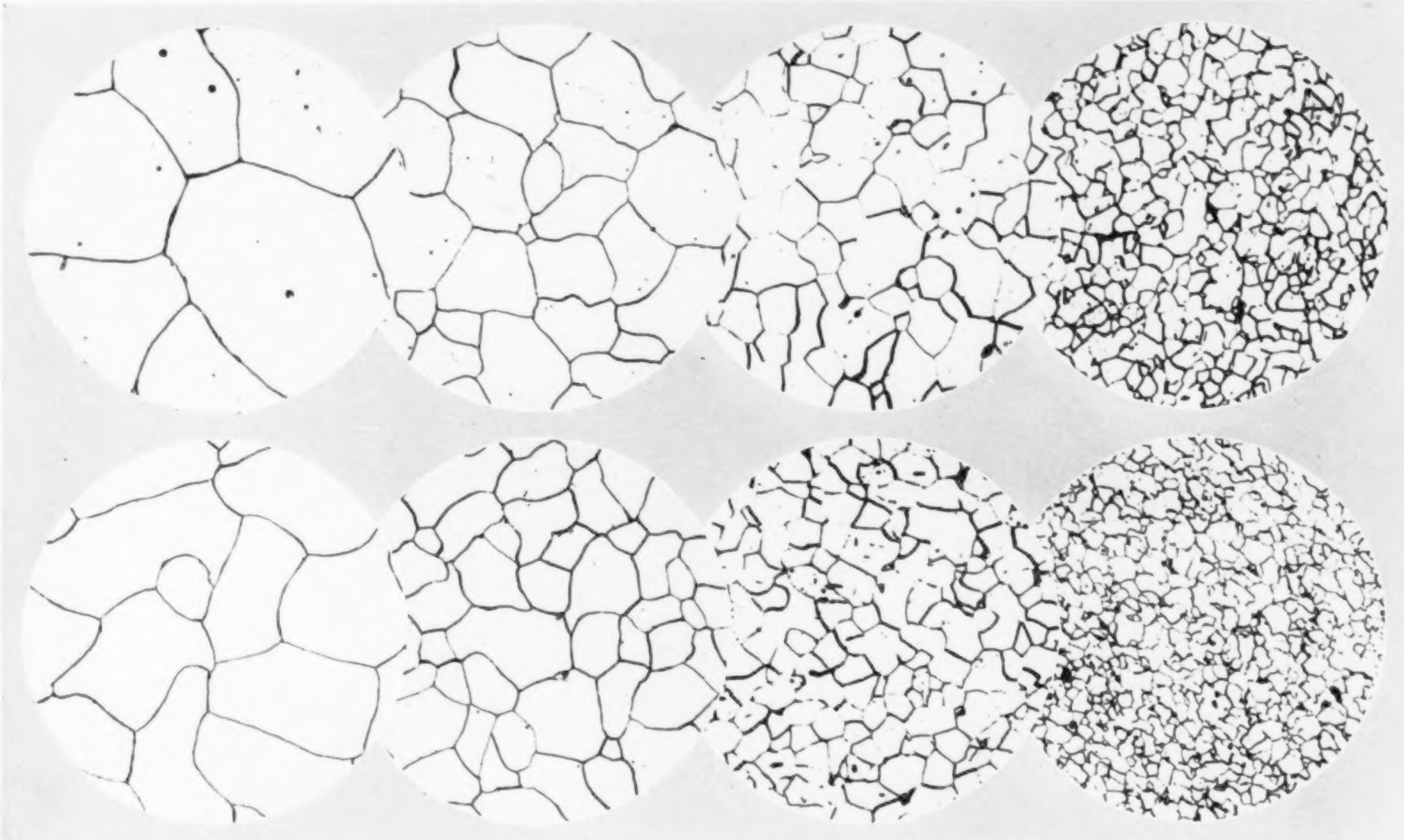
Etchant 5% nital, 100×. Micros courtesy R. S. Penrod, Chief Metallurgist, Bethlehem Steel Co.

Grain Size No. 1; Up to 1 grain per sq.in.

Grain Size No. 3; Up to 4 grains per sq.in.

Grain Size No. 5; Up to 16 grains per sq.in.

Grain Size No. 7; Up to 64 grains per sq.in.



Grain Size No. 2; Up to 2 grains per sq.in.

Grain Size No. 4; Up to 8 grains per sq.in.

Grain Size No. 6; Up to 32 grains per sq.in.

Grain Size No. 8; Up to 128 grains per sq.in.

Yesterday this was an Empty Room

To convert an empty room into a modern, completely equipped, operating chemical laboratory figuratively overnight is quite a feat . . . even for Fisher! But we did it.

At 3:30 one afternoon came urgent instructions from an eastern metals firm. At 4:45 our shipping department was getting out the order. The *next* morning the customer was uncrating the complete laboratory assembly, and by that afternoon every section of Fisher Unitized Furniture was in place.

We'd prefer not to be quite so rushed. But we *could* do it again *because* Fisher scientifically planned laboratories are made up to your exact specifications from modular, unitized steel laboratory furniture of most practical design.

More than 21 basic units are available from stock. Put together to meet your requirements, the result is an integrated laboratory, completely modern in appearance and efficiency.

Providing complete laboratories is only one facet of our interesting business. Implementing them with apparatus, instruments, supplies, reagent chemicals, glassware, even to suggested procedures and techniques, are others. Everything but providing the chemist, metallurgist or technician himself!

Whatever your laboratory problem or need . . . *take it to Fisher first.*

Fisher Scientific Company—Plants and Complete Stocks: Pittsburgh, New York, Washington, St. Louis, Montreal, Toronto. Branch Offices: Buffalo, Chicago, Cleveland, Detroit, Philadelphia.

FISHER SCIENTIFIC

America's Largest Manufacturer-Distributor of Laboratory Appliances and Reagent Chemicals

MATCH YOUR EQUIPMENT TO YOUR PROBLEMS

with Bausch & Lomb . . . the world's most complete line

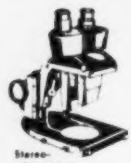
CM Metallurgical Microscope

Model L Photomicrographic Equipment

Balphot Metallograph

You can't expect versatility from equipment that is designed *only* for average routine analysis. *Specific* problems like yours set the specifications for the wide range of Bausch & Lomb metallurgical equipment. It's tailor-made to fill your most exacting requirements in advanced research or production control. For fast, dependably accurate results, choose from the world's finest all-inclusive line.

- **Four different metallographs—for routine bright field studies—or advanced analyses requiring interchangeable phase contrast, bright field, dark field and polarized light.**
- **Photomacrographic Equipment Model L—widest low power range; no time lost in converting metallograph from high power set-up.**
- **CM Metallurgical Microscope—industry's standard.**
- **Stereomicroscopes—unequalled for 3-dimensional low power studies.**
- **Eyepiece Camera—fits microscope eyepiece tube. Make your own projection slides or "work-in-progress" records. 35mm or $2\frac{1}{4}'' \times 3\frac{1}{4}''$ film.**
- **Polaroid Land Camera Attachment—fits low and high power camera equipments. Finished print *in one minute!***



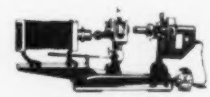
Stereo-microscopes

Eyepiece Camera

Polaroid Land Camera Attachment

Research Metallograph

ILS Metallograph



MILS Metallograph

WRITE OR PHONE FOR PROMPT EXPERT ADVISORY SERVICE

Let us help you select the equipment and set up the operating procedures that will most efficiently solve your problems. No obligation, of course. Just write or phone Bausch & Lomb Optical Co., 63819 St. Paul St., Rochester 2, N. Y. Phone. LOcust 3000

1853/1953 INTO A NEW CENTURY OF OPTICAL PROGRESS

BAUSCH & LOMB CENTENNIAL

Bausch & Lomb *Metallurgical* Equipment

By H. J. PESSL, Assistant Works Manager
Defense Products Div., Gibson Refrigerator Co.
Greenville, Mich.
and H. H. HAUTTMANN
Director of Research and Development
United Austrian Iron and Steel Works
Linz, Austria

Early Experiments in the Cold Extrusion of Steel

COLD EXTRUSION of steel is a process with an unusual origin; like the bessemer process it is one of our important inventions which was made by an inquisitive amateur. Its inventor, A. Liebergeld, was a toolmaker at the Neumeyer Metal Works in Nuremberg, Germany. While experimentally cold pressing shells from thick-walled brass cups (about ⅝-in. wall), he tried a cup made of soft boiler plate – cold. The result was surprising, since the steel was cold and the tools were those conventionally used for the cold forming of brass. This experiment was much more encouraging than the steel experts would have expected. Although heavily scored by the badly worn die, the finished piece had almost attained its intended shape.*

The engineering staff of the Neumeyer Metal Works quickly realized that the principal factor necessary to convert Liebergeld's experiment into a working process for the cold extrusion of steel was the application of a suitable lubricant to prevent scoring or seizure of workpiece and die. About a year previously, F. Singer,† then also an employee of the Neumeyer Metal Works, had obtained patents covering the use of chemically produced nonmetallic surface coatings, especially phosphates, to facilitate the cold forming of steel. He first proved its technical importance in cold drawing of steel tubes. It was therefore soon discovered that a phosphate coating acted as gliding agent and a lubricant retainer. It only remained to discover a proper lubricant to put the cold extrusion of steel on a technical and economical basis. It was also desirable to discover how the various commercial steels reacted in extrusion dies, so one could select the best type for a given job.

Its technical development was completed in 1938 and the process was quickly adopted by German steel fabricators. It was used in the mass production of hollow articles with heavy bottoms such as steel cartridge cases, and of various tubular parts having pronounced differences in cross section. In this way steel replaced brass to a very large extent and relieved the wartime shortages in copper and zinc. At the same time phosphate coatings, while considered indispensable for steel extrusion and for severe deep draws, have also been more and more widely used in practically all cold fabrication processes for steel parts.

Extrusion is characterized by a more thorough kneading of the material than is possible by any other manufacturing method. Ordinarily, the steel is pushed through a circular or annular orifice of a die, thus greatly re-

*German Patents No. 717,679; 720,543; and 728,764, 1942.

†German Patent No. 673,405, 1934; U. S. Patents No. 2,105,015 and 2,116,954, 1938.

ducing the cross-sectional area. Simultaneously there is much frictional heat liberated. The cold slug emerges too hot to handle without thick gloves. The punch and especially the die get hotter and hotter as more and more pieces are pushed through. Herein lies one of the problems which early research had to surmount. Lubrication is not so difficult on the first part, especially if the press acts very slowly. However, at mass production rates the dies become so hot that many of the conventional lubricants have no virtue.

In 1936 H. J. Pessl was the principal assistant of H. Hauttmann, then head of the research and testing laboratories of Gutehoffnungshuette Oberhausen, in the Rheinland, Germany. Dr. Pessl was in charge of research and experimentation on the development of this new process. For four years we studied the elements of cold extrusion of steel, discovered, as mentioned above, in one of the company's subsidiaries in Nuremberg. We were therefore in the singularly fortunate position of being able not only to supervise the manufacture of the steels to be tested, but also to follow them through the processing operations at Nuremberg and even to study the behavior of the extruded parts in the proving grounds as well as while they were in actual service.

PRINCIPAL APPLICATIONS

Some of the principal applications of cold extrusion are shown in the six different forming operations schematically illustrated in Fig. 1, the drawings being more or less self-explanatory. The proportions of the blanks are indicated in the upper left corner of the sketches. The "flow" of the blank or work-piece can take place in the same direction as the punch is moving, as in *a*, *b*, and *d* and this is called "direct extrusion". Or it may flow in the opposite direction as in *c* and (principally) in *f*, and this is known as indirect or backward extrusion. Or flow may be in both directions simultaneously, as illustrated by the shapes shown in Fig. 1*e* and *f*.

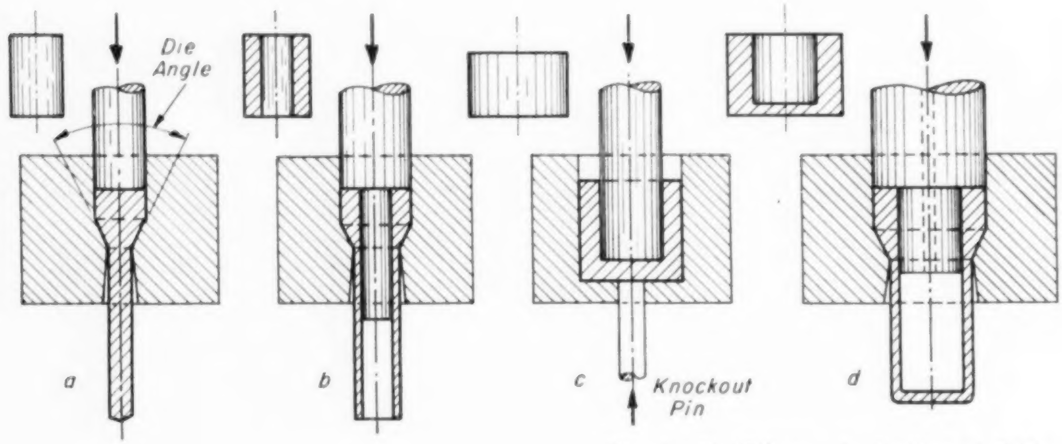


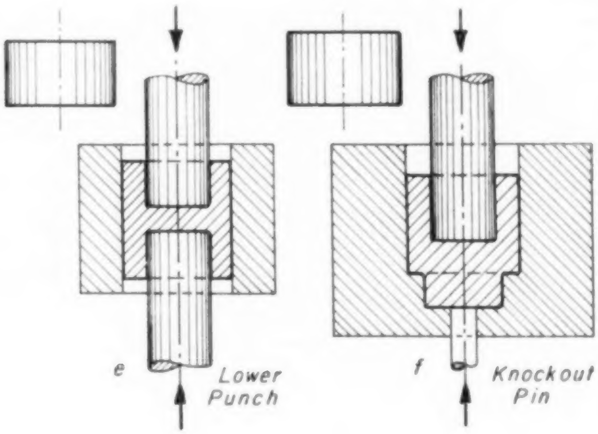
Fig. 1 – Six Different Applications of Cold Extrusion of Round, Pierced or Cupped Blanks Shown at Upper Left of Each Diagram. Flow of the blank may be in either the same or the opposite direction as the punch

Figure 1*a* represents the type of split die we used in most of our experimental work, wherein a round blank is forward-extruded into a rod of smaller diameter. Figure 1*b* represents schematically the extrusion of seamless tube from a pierced blank. Figures 1*c* and *d* represent the manufacture of a hollow steel projectile or cartridge case; first a cup is made of proper base thickness as in 1*c*, and the walls of this are then drawn thinner as in 1*d;* the end is then trimmed and necked. 1*e* shows how a double cup or tube can be made with an interior barrier, and another somewhat complicated shape is shown in Fig. 1*f*.

The cross sections of the extruded products are usually of circular or annular shape but may also be oval or polygonal with rounded edges. Extrusions with sharp-edged cross sections generally cause difficulties; the sharp corners tend to fracture because surface coatings and lubricants are not effective at edges. If the parts are difficult to eject, split dies can

be used, or a second blank can be inserted in the die to force the first extrusion completely through the die.

It is possible to combine the cold extrusion process with other cold forming operations. In Fig. 2, for instance, the tooling assembly is shown for cup drawing and cold extrusion in a single operation. Even with the use of double or triple successive draws, deep drawn steel is mainly formed by tension stresses in the piece being worked. These stresses are



imposed by action of punch and die, and they set a definite limit to the reduction of area of the cross section.

On the other hand, the flow of material in the extrusion method is achieved by compressive stresses, and the amount of reduction in a single pass is not restricted by the tensile strength of the material which is being worked.

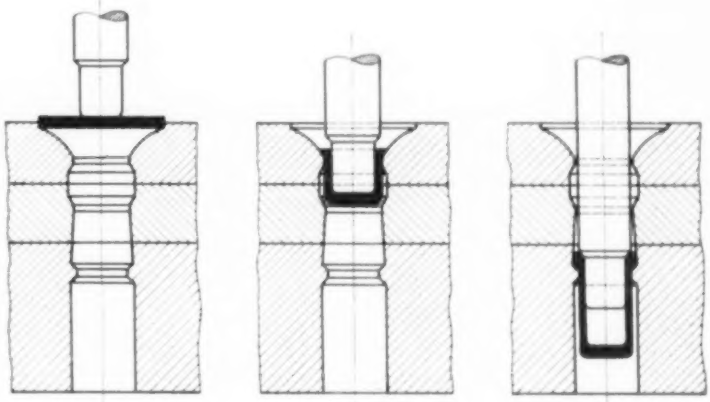
Minimum wall thickness of cold extruded annular cross sections for punch diameters from 3/8 to 3/4 in. is about 0.02 in. Minimum walls are proportionately thicker for larger punches: 0.025 in. for 1-in. punches, 0.040 in. for those 1 1/2 to 3 in. and 0.075 in. for larger punches. The length of cold extruded steel products made by conventional manufacturing operations has so far not gone beyond 80 in.; however, fabrication of longer products is possible. Long extruded steel products can be subsequently straightened to close requirements. Cross-sectional tolerances can be held within extremely narrow limits. The wall thickness tolerances of hollow tubular articles, for instance, can be held at about ±0.002 in. for punches 1/2 in. in diameter and ±0.010 in. when punch diameters are over 3 in.

The pressure required for the cold extrusion of a normalized low-carbon steel through a die with an angle of about 125°, resulting in 75% reduction of cross section, amounts to around 200,000 psi., as measured on the effective cross section of the punch in transmitting the pressure.

The choice of the proper material for the highly stressed tools is of paramount importance. Only toolsteels of highest wear resistance, strength and ductility should be used. Punches, for instance, can be made of high-carbon, high-chromium steel (11 to 13% Cr), while nickel-chromium steel (for instance, 0.5% C, 1.2% Cr, 4.5% Ni) or even especially tough and hard plain carbon toolsteels are satisfactory materials for extrusion dies and die holders, respectively.

The tool life depends upon a number of factors such as the type of the extrusion operation, the degree of cold reduction, the material of the workpiece as well as that of the tools, and the tool design. Under favorable conditions a punch and die will produce from 20,000 to 150,000 workpieces, reaching the higher number if the required tolerances are not too small. Hard chromium plating was found to be of

Fig. 2 – Cross Section of Tools for Cup Drawing and Wall Thinning (by Extrusion) in a Single Operation



Pressure - Travel Diagrams Plotted

advantage in resizing tools. Good results were also obtained with cemented carbide tools.

While the carbon contents of the steels which were cold extruded on a mass-production scale in Germany during 1940 to 1945 generally ranged between 0.06 and 0.35%, corresponding to tensile strengths of from 50,000 to 80,000 psi., the favorite steels had between 0.06 and 0.12% carbon. This type of steel work hardens sufficiently in cold forming to satisfy the specific requirements. Steels to be cold extruded must be as free from surface and internal defects as possible; this requires special precautions in their manufacture. Aluminum-bearing, nonaging steels proved to be by far the most satisfactory material for parts which are subjected to high stresses in service.

COLD EXTRUSION EXPERIMENTS

The general mechanism of the cold extrusion process has been briefly outlined above. Results of some experiments which were carried out by H. J. Pessl and H. Hauttmann, principally between 1936 and 1938, and also some more recent test results will now be given.

The purpose of these experiments was to determine the pressure required for cold extrusion of steels in relation to *(a)* the lubricant, *(b)* die design, *(c)* reduction in area of cross section, and *(d)* the kind of steel extruded. The changes in properties of steels resulting from cold extrusion were also determined. Of the various possible shapes of extruded products only the circular and annular cross sections will be considered.

An 80-ton hydraulically operated, universal testing machine with a maximum punch speed of 10 in. per min. was used for these experiments. Pressure-travel diagrams were plotted by means of a directly coupled recorder. In addition to the regular one-piece dies, split dies were also used so the workpieces could be examined at every stage of deformation.

The full angle of the shoulder adjacent to the orifice of the die (known as the die angle, Fig. 1*a*) was changed within a range of 40 to 180° in steps of 40, 90, 126, and 180°. A die angle of 110° was used to extrude circular test pieces. In various dies identical blanks were extruded with 48, 52, 56, 64 and 70% reduction of cross-sectional area.

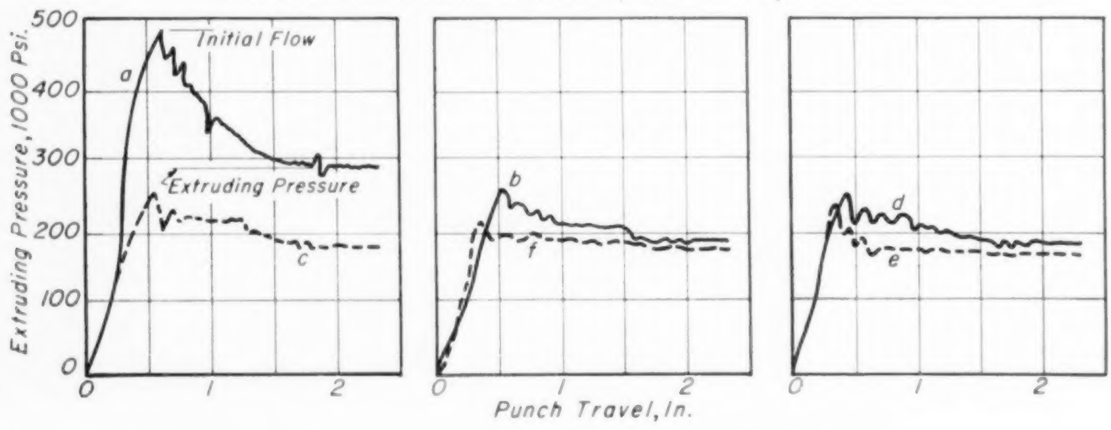
Some blanks of rimmed 0.03% carbon steel were extruded in a die with 126° angle into a rod with 90% reduction of cross-sectional area. The blank was 0.787 in. in diameter, the extruded rod 0.236 in. The pressure required was recorded at 255,000 psi.

EFFECT OF THE LUBRICANT

Surface treatment of the blank plays a most important part in the cold extrusion process – it not only prevents scoring but also greatly influences the pressure required. The beneficial effect upon the drawability of steel wire of a slightly rusted or lime-coated surface combined with a proper lubricant is well

Fig. 3 – Effect of Lubricants and Surface Coatings on Pressure Required for Cold Extrusion. Tubular test pieces were of 0.05% C rimmed steel, 0.787 in. outside diameter, 0.079-in. wall. Die angle 126°; 75% reduction in cross-sectional area

a – Viscous mineral oil
b – Fat only
c – Vaseline plus amorphous carbon
d – Lead coated plus lubricant
e – Copper coated plus lubricant
f – Zinc coated plus lubricant



known. The lubricating methods commonly used in wiredrawing, however, were wholly inadequate for cold extrusion, where reductions of cross section are much greater. Preliminary trials with conventional lubricants such as animal and vegetable oils and fats, soaps, vaseline and tallow were as unsuccessful as were tests with viscous mineral oils. Fatty lubricants become ineffective at the high temperatures reached by the tools after a number of extrusions. While the addition of fillers such as amorphous carbon and graphite brought some improvement, they offered no practical solution of the problem.

In view of the high frictional forces which occur in the die orifice during cold extrusion, and the proven usefulness of metallic and nonmetallic surface coatings in the cold drawing of steel, it appeared that a combination of such a coating with a lubricant of the right kind might solve the problem. Experiments were therefore carried out with a number of metallic and salt-type surface coatings. Best results were obtained with electrolytically deposited, spongy copper and zinc coatings and with chemically produced phosphate coatings or iron oxide coatings from an oxalic acid solution. The effectiveness of the nonmetallic salt coatings in preventing scoring and lowering the power consumption compared favorably with the best metallic coating – namely, zinc. With all of these surface coatings an additional fatty acid or soap emulsion type of lubricant is considered essential.

Phosphate coatings used in the cold extrusion of steel are produced by basically the same methods as phosphate coatings for corrosion protection. A modified phosphating

Six Lubricants Tested

solution gives a sufficiently thick coating at room temperature within a few minutes. Because they do not lose their effectiveness at the high temperatures resulting from friction in cold forming operations, phosphate coatings have since been successfully adapted in many other cold forming operations on steel besides extrusion with equal success.

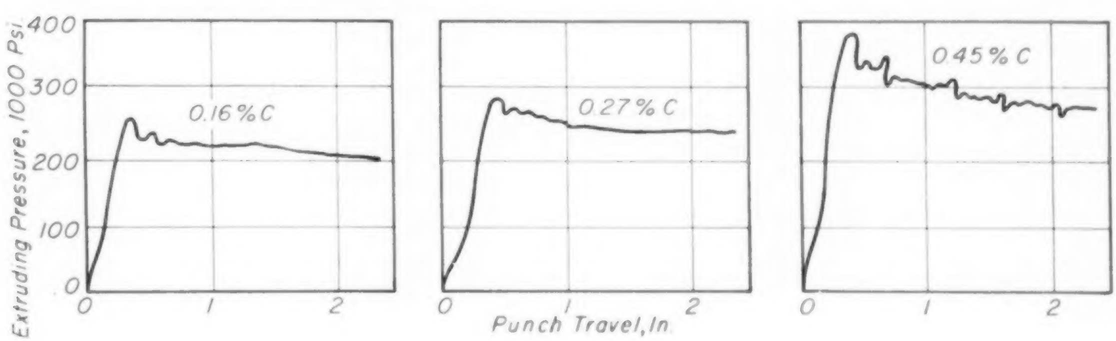
Some of the results of the experiments on lubricating methods are shown in Fig. 3 and 4, in which travel of the punch is plotted against the pressure required to extrude hollow tubular test pieces with 126° die angle to 75 and 65% reduction of cross-sectional area. All of the curves show a characteristically steep rise in pressure up to the point where the lower end of the blank has reached the extrusion orifice and has overcome internal resistance to flow and external friction.

As soon as the material starts to flow, pressure decreases, at first abruptly, then gradually reaching a more or less constant minimum. The difference between the initial and the extruding pressure depends upon external friction as well as internal (inherent) resistance to deformation of the test piece.

As shown in Fig. 3*a*, the use of viscous mineral oil requires a pressure of 285,000 psi. to extrude a tube from rimmed low-carbon steel to 75% reduction of cross section. If ball bearing fat is substituted (Fig. 3*b*), the pressure is reduced to 205,000 psi. Use of vaseline mixed with 30% amorphous carbon (3*c*) reduces the extruding pressure still further. As the die becomes hot, however, the effect of the fatty lubricants diminishes, and at 300° F. the lubricants of 3*b* and *c* would give curves similar to 3*a*, other conditions being equal.

Curves *d*, *e*, and *f* show the effect of electrolytically deposited metallic coatings combined with fatty lubricants; the copper and zinc-

Fig. 4 – Effect of Phosphate Coatings on Extrusion Pressure for Three Steels of 0.16, 0.27 and 0.45% C Respectively. Test conditions were same as Fig. 3 except reduction in cross-sectional area was 65%



Phosphates for Extrusion

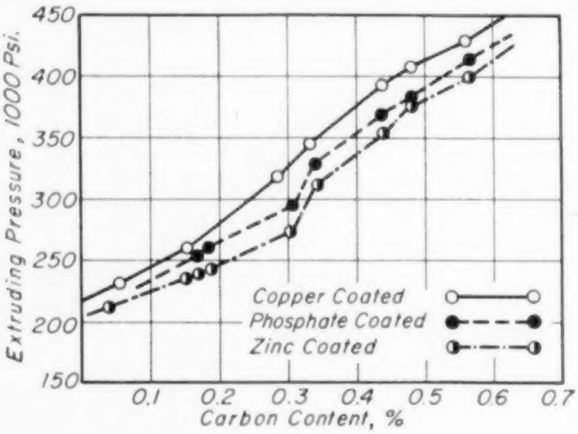
coated test pieces required the lowest extruding pressures. The advantage of metallic coatings, however, is not limited to the generally lower extruding pressures (their difference compared with Fig. 3c being almost negligible), but lies largely in the fact that the lubricants retain their effectiveness at the higher die temperatures encountered in manufacturing operations.

Table I – Phosphate Versus Metallic Coatings

	Phosphate Coating	Zinc Coating	Copper Coating
Steel 7, 0.16% C			
Initial flow	260,000 psi.	250,000 psi.	350,000 psi.
Extrusion pressure	185,000	190,000	250,000
Steel 9, 0.27% C			
Initial flow	280,000	270,000	330,000
Extrusion pressure	240,000	210,000	250,000
Steel 10, 0.45% C			
Initial flow	370,000	340,000	370,000
Extrusion pressure	270,000	290,000	280,000

Pressure-travel diagrams shown in Fig. 4 demonstrate the effectiveness of a nonmetallic phosphate coating. In these experiments the tubular test pieces described in the caption of Fig. 3 were extruded from three steels of 0.16, 0.27 and 0.45% carbon respectively to a 65% reduction of cross section. Comparative figures for the best metallic coatings (plus lubricant) are shown in Table I, which clearly indicates that a copper coating in combination with fat lubrication is inferior to a phosphate or a zinc coating, the latter two being essentially equivalent. This holds true for the low-carbon as well as the higher carbon steels. Noteworthy is the fact that the pressure required for cold extrusion of steels with increasing hardness does not increase in the same way as yield strength or tensile strength but remains somewhat below the former values. It can be concluded, therefore, that such surface coatings become more effective as extrusion pressure becomes higher.

Fig. 5 – Variation of Extrusion Pressure With Carbon Content of Steel for Three Types of Coatings. Tubular specimens 0.787 in. inside diameter, 0.12-in. wall thickness. Reduction of cross-sectional area 80%



Phosphate-coated surfaces appear light grayish and glossy after cold extrusion, while parts coated electrolytically with copper and zinc tend to discolor. A serviceable finish can be obtained only with comparatively thick coatings. Phosphate coatings can be easily removed by a hot caustic soda solution, while metallic coatings, especially zinc, are difficult to remove. This is a prime consideration responsible for the commercial adoption of phosphate coatings.

Further results confirming the influence of copper, zinc and phosphate coatings on extrusion pressure are plotted in Fig. 5. Several steels with carbon from 0.04 to 0.57% were cold extruded through a die angle of 126° with a reduction in cross section of 80% into tubes 0.787 in. in inside diameter with 0.12-in. walls. Extrusion pressure is plotted against carbon content. These curves also show that the copper-coated blanks required the highest pressure and the zinc-coated the lowest. The curve for the phosphate-coated samples lies between these two and closer to the curve for zinc-coated test pieces. In these tests bearing fat was used as an additional lubricant. The step in the pressure curves at 0.33% carbon indicates the change from rimmed low-carbon steels to the killed higher carbon types. At that point the extrusion pressure increases almost in a straight line with increasing carbon.

These results show that phosphate coatings are almost as good as copper and zinc, and offer the further advantage of ready removal.

In a subsequent issue some additional experiments on the effect on extrusion pressure of die angle and reduction of cross-sectional area will be described. Influence of steel composition will also be considered, and results of impact and simulated service tests on extruded parts will be evaluated.

Reported by STUART P. HALL
Hall Industrial Publicity, Inc.
Detroit

Cost Considerations Emphasized at Electric Heating Conference

COST CONSCIOUSNESS of metallurgists in industry today was obvious from the number of papers that emphasized cost considerations in a conference on electric heating held in Detroit on May 26 and 27. Sponsored jointly by the Committee on Electric Heating and the Michigan Section of the American Institute of Electrical Engineers, in cooperation with the Industrial Electrical Engineers Society of Detroit, the meeting drew a registered attendance of more than 400 industrial heating engineers from all parts of the country. Technical sessions for the 20-paper program were filled to overflowing – so much so that closed-circuit television was provided for listeners in adjoining rooms to view the proceedings.

CONTINUOUS PROCESSES FOR METAL STRIP

An electric furnace with metallic resistor elements is a most economical method for continuously heat treating or annealing cold reduced steel strip, according to C. E. Peck of the Westinghouse Electric Corp.'s industrial heating division.

Peck compared the costs of ten methods of annealing 30 tons per hr. of steel strip 0.010 in. thick and 30 in. wide at a speed of 1000 ft. per min. The strip was assumed to be heated to 1330° F., with no soak allowance, from both sides at the same time. The ten methods were high-frequency induction, 9600-cycle induction, electrical conduction, radiant heating on gradient with molybdenum elements, silicon carbide elements and nickel-chromium metallic resistors, radiant heating without gradient with nickel-chromium resistors, direct gas-fired radiant heating on high gradient, and gas-fired radiant tubes on both gradient and no gradient.

When inexpensive gas is available, a combination of gas for heat-up and electric heat for soak and slow cool is the preferred method, according to Peck's conclusions. High-speed electric heating methods such as induction are too expensive for heating strip on a large tonnage basis in high-temperature processes, he concluded, particularly when a considerable amount of space is required beyond the initial heat-up section.

Continuous heating methods should only be considered for productions of at least 10 to 15 tons per hr. on light gage strip and 15 to 20 tons per hr. on the heavier gage strip.

Continuous annealing and heat treating of nonferrous strip by the transverse flux induction method were discussed by Robert M. Baker of Westinghouse Electric Corp. He predicts wide application for this method on aluminum and its alloys, brass, copper and magnesium, as well as nonferromagnetic metals such as austenitic stainless steel and ordinary carbon steel above the Curie temperature.

One of the problems in this process is the measurement and control of strip temperature. Radiation sensing devices are used, but variations of 0.05 to 0.15 in emissivity (of aluminum alloy strip in particular) from one batch to another affect the measurement of strip temperature. The problem is minimized if the strip has a high initial emissivity.

A cost analysis of the transverse flux induction method revealed a heating cost of about \$6.36 per ton for the solution heat treatment of aluminum alloys. This study was for aluminum alloy strip 0.04 in. thick by 48 in. wide, fed at a speed of 60 ft. per min. Temperature

rise in the coils is 810° F., and in the furnace 50° F. Final heat treat temperature is 930° F. Holding time in the furnace was assumed to be 1½ min. The equipment was to produce 20,700 tons of strip a year in a 5000-hr. operating period. The process was described in the October 1951 issue of *Metal Progress*, p. 88.

FURNACE ATMOSPHERES AND CONTROLS

Special atmospheres for electric furnaces were covered by A. G. Hotchkiss of General Electric Co. in a paper based on his forthcoming book, "Protective Atmospheres", to be published by John Wiley and Sons.

Mr. Hotchkiss pointed out that while theoretical equilibrium conditions can be used as a guide when dealing with furnace atmospheres, from a practical standpoint many other factors may affect the anticipated results. Among these are time, temperature, volume of atmosphere, materials in contact with the atmosphere, composition of the atmosphere, condition of the metal and impurities.

Some of the conditions metallurgists should avoid to minimize these factors are: *(a)* high moisture content in atmospheres for bright annealing steel in batch-type furnaces, *(b)* nonuniform surface temperatures, *(c)* large volumes of fresh gas sweeping over the work, *(d)* carbon dioxide in atmospheres containing hydrogen, nitrogen and carbon monoxide, *(e)* oxide coatings, oil or lubricants on metal parts, *(f)* air or water entrapped in parts and hot furnace seals that may generate steam.

Typical applications of the recently developed "Carbohm" element for control of furnace atmospheres were described by Wayne L. Besselman of Leeds & Northrup Co. The system that utilizes this element measures and controls the carbon potential of a furnace atmosphere directly and continuously.

The basic principle of the Carbohm element is the measurement of the electrical resistance change of a fine wire (iron alloy) due to the chemical absorption or loss of carbon at elevated temperatures.

The carbon potential can be controlled within a range of 0.15 to 1.15% C for heat treatment of steels in carbon-bearing atmospheres at 1450 to 1750° F., Besselman said. The over-all accuracy is ±0.05% carbon.

The types of heat treatment to which the control system can be applied include controlled surface carburizing, carbon restoration, hardening and homogeneous carburizing. Typical case histories of parts processed in various furnace atmospheres were described. Among these was a highly stressed part of S.A.E. 1315 steel whose surface carbon concentration was specified at 0.80 to 0.95% for superior metallurgical characteristics. Micrographs before and after the 2-hr. carburizing cycle revealed complete absence of carbide networks, massive carbides and retained austenite.

An interesting application to a decarburization problem involved a rifle bolt with an S.A.E. 4640 head that was copper brazed at 2050° F. to a C1137 body. Decarburization of 0.20 in. on the head and 0.040 in. on the body could not be prevented in the brazing process. A carbon restoration cycle of 2 hr. at 1700° F. with the atmosphere controlled to 0.40% carbon potential eliminated the partially decarburized layer on both head and body.

Homogeneous carburizing of parts less than ⅛ in. in cross section was recommended as a definite possibility. Mr. Besselman cited the case history of a rifle carrier mechanism that had been machined from S.A.E. 1070, ¾-in. square bar stock and heat treated. It was replaced by a design utilizing S.A.E. 1010 stamped sheet 0.052 in. thick, cold formed and carburized. The homogeneous carburizing cycle for this lower cost design was 2 hr. at 1700° F. Photomicrographs revealed a satisfactory grain structure. Other examples of lightweight parts that would respond to such homogeneous carburizing are fasteners, spring clips, lock washers and parts for typewriters and business machines.

FURNACE TYPES AND APPLICATIONS

Electric Furnaces – Determination of the source of energy for a heating process depends on five factors, according to A. R. Ryan of General Electric Co., who described "Electric Furnaces for Sintering, Brazing, Aging and Annealing". These factors are quality and uniformity of product, labor and supervision costs, maintenance, working conditions, and cost of the heat source.

Ryan described the trend of the malleable iron industry from annealing furnaces fired by powdered coal to today's electric elevator furnace that has low-cost alloy baskets, a time cycle one quarter that of the fuel-fired furnace, and the ability to produce parts of consistent high quality.

One way to economize with the electric furnace is to combine two precise heat treatment

operations in one furnace. A typical example is a tank tread link that consists of two forgings and two seamless steel tubular components. These parts are brazed and hardened in a single roller-hearth furnace, and drop into a quench tank from which they are removed by a conveyer. The combination furnace provided a 40% saving in power over that required by the hardening operation alone.

In tin plating, continuous electric furnaces produce more uniform physical properties and surface conditions than those attained by batch annealing.

Higher output per man-hour with electric furnaces is the result of three factors: *(a)* Higher temperatures can be attained with accuracy and safety; *(b)* tightness of the furnaces permits use of protective atmospheres that preserve and improve surface finish; and *(c)* automatic conveying and handling equipment cuts labor costs and eliminates human errors. Sales of electric heat treating furnaces during the past year approximated 180,000 kw. – about 39% of all industrial furnaces sold.

Salt Bath Furnaces – The average size of salt bath furnaces has increased from 50 kw. to 100 kw. in the past ten years, according to L. B. Rousseau, vice-president of Ajax Electric Co. Output has been speeded by the addition of specially designed materials-handling equipment that carries the parts through quench tanks, wash tanks and dryers.

The speaker pointed out the value of combining a martempering and carburizing process. Many gears, for example, must be ground and lapped after carburizing and hardening. These final finishing operations may be eliminated if the hot carburized part is immediately placed in a martempering bath.

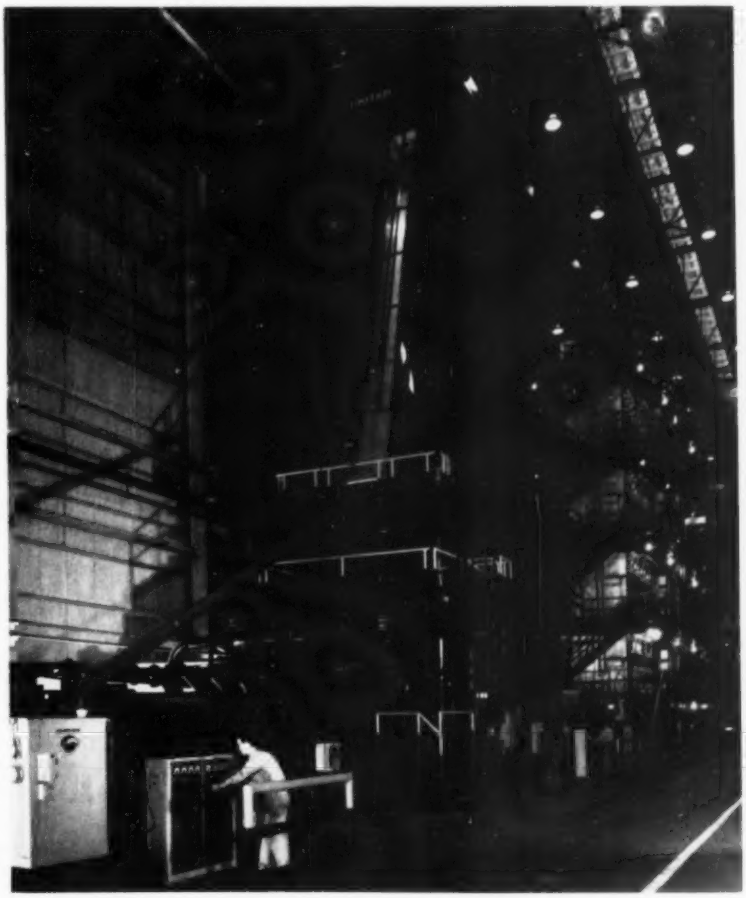
A prominent automobile manufacturer has adopted the cycle annealing process in a novel manner by utilizing the residual heat in forgings as they come from the hammer. The hot forgings, above the critical temperature, are

quenched in an agitated salt bath operating at the subcritical temperature of the S.A.E. 8620 steel used (1150 to 1250° F.). Transformation to the desired pearlitic structure takes place in approximately 45 min. The forgings are then flash-quenched in water, which removes all of the salt and most of the scale. A single operator produces 5000 lb. of forgings per hr.

A sodium hydroxide salt bath can be used for descaling, and on stainless steel will keep metal loss below ½% as against 1½ to 4% when strong acids are used for cleaning.

Electric Arc Furnaces – European developments in arc furnaces are still ahead of American achievements, W. B. Wallis, president of Pittsburgh Lectromelt Furnace Corp., told the conference. The magnitude of the American market has probably been the reason for our lag in this field, Wallis said. The pressure

Continuous Annealing Line at United States Steel Corp.'s Sheet and Tin Mill at Gary, Ind.



in America has been for production, and designs have been frozen, while in Europe a small but highly competitive market spurs development. The one American invention in the arc furnace field – and one that Europeans are now using – is the swing-aside roof top-charging mechanism.

Better quality steel from electric furnaces will result from the recent installation of induction stirrers in this country, Wallis predicted. These stirrers improve metallurgical quality of the steel by accelerating reactions, producing quick homogeneity, equalizing temperatures and reducing labor at slag-off. Induction stirrers such as those installed at Timken Steel and Tube Division (*Metal Progress*, February 1953, p. 88) are a Swedish development, but similar stirrers having rotating electromagnets are also being proposed in this country.

In Belgium, some plain carbon steel is being produced in electric arc furnaces, but Wallis stated in discussion that the arc furnace can replace the openhearth economically only if a 60% hot metal charge is used in conjunction with complete utilization of waste heat.

By 1954 the largest electric furnace in the world will go into operation in Europe, and will be followed in a short time by two of similar size in Detroit.

ELECTRIC VS. OPENHEARTH FURNACES

The arc furnace produced about 7% of the steel made in the United States in 1951, George H. Whitewell, vice-president of the Philadelphia Electric Co., pointed out in a banquet speech. A recent study appraising competitive aspects in producing plain carbon steels showed that the capital outlay for a modern electric furnace is about 60% of that for a comparable openhearth furnace. The area required, including charging, melting and pouring, may be only 60 to 70% of that required for an openhearth. Over-all operating costs of electric steel melting closely approach those of the openhearth and often are lower. Whitewell predicted more and larger electric melting installations.

Induction Heat – H. B. Osborn, Jr., technical director of the Tocco Division of Ohio Crankshaft Co., predicted that the use of induction heat for hardening engine cylinder bores will go down as one of the most important developments of the past ten years. Savings result from the elimination of expensive space-consuming cylinder liners, and induction hardening of the bores avoids the necessity for alloy iron castings that are difficult to machine. Hardness depths can be about $\frac{1}{16}$ in., which will take several honing operations at intervals during use with no loss of bore hardness.

Another cost-saving operation on cylinder blocks is the induction hardening of valve seats which makes the use of valve inserts unnecessary.

A typical case history of an S.A.E. 1030 axle shaft that is machined in the as-forged condition and surface hardened by induction to about Rockwell C-50 after drawing illustrated another automotive application. The shaft was previously a more expensive alloy steel heat treated to Brinell 300 and then machined. The induction hardened shafts are 200% stronger in torsional fatigue, and cost from 25 to 40¢ less apiece. (For additional trends in induction heating, see *Metal Progress* for May 1953, "Critical Points", p. 65.)

Induction furnaces are also useful for providing extremely high temperatures. The upper limit that can be reached in furnaces of any type appears to be 3600° C. (6500° F.), Frank T. Chesnut of Ajax Electrothermic Corp. stated. 3600° C. is the vaporizing point of graphite, the best electrical conductor that has yet been found for high-temperature work. These high temperatures are commercially attained in large graphite induction muffle furnaces; those with nongraphitic muffles appear to be limited to about 2200° C. (4000° F.). [By way of comparison, Mr. Chesnut noted that the hydrogen arc is said to give temperatures of 6000° C. (11,000° F.), and the atomic bomb generates "temperatures" on the order of 10,000,000° C.]

The speaker told of a promising, but as yet noncommercial, method of producing graphite from waste petroleum coke. The coke is fed through a graphite muffle where it is heated for 18 min. at 2800° C. (5100° F.). After traversing the hot zone it cools as it progresses down the tube and is discharged on a screw conveyer. Commercialization of this process is being held up for lack of a method to slow deterioration of the outside of the graphite tube; also needed is an easy way to replace the tube parts at intervals during the continuous process. Deterioration is now 1 in. per hr. in 30 hr. of operation.

The atomic energy and jet engine programs have spurred such high-temperature research, Chesnut said.

Advertisement

ELECTROMET *Data Sheet*

A Digest of the Production, Properties, and Uses of Steels and Other Metals

Published by Electro Metallurgical Company, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y. • In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario.

Why 3 Per Cent Chrome Steel Makes Good Castings for Wear Resistance

Castings of 3 per cent chromium steel have been used in substantial tonnages, for many years, for various equipment parts demanding good wear resistance. Such castings offer an excellent combination of hardness and toughness. Typical applications are crusher parts used in rock- and ore-crushing equipment, swing hammers for pulverizing coal, railroad switch frogs, gears, pulleys, sheaves, and other castings that must meet severe conditions of wear.

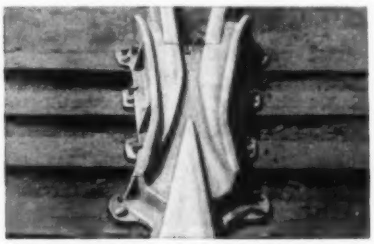


Fig. 1. Railroad switch frogs, which are subject to severe wear, give outstanding service when cast of 3 per cent chromium steel.

The 3 per cent chromium steels, are normally produced in a carbon range of 0.30 to 0.50 per cent. They exhibit excellent depth-hardening properties, which simplify heat-treatment and insure uniformity throughout heavy sections. The analysis is usually modified by a molybdenum addition, since this element aids in increasing hardenability.

Fig. 2. Grating for top of shake-out machine is cast of 3 per cent chromium steel to give good wear resistance and long life.

Properties Improved by Heat-Treatment

The best properties of 3 per cent chromium steels are developed through heat-treatment. Generally, this consists of a normalizing treatment from 1650 deg. F., followed by tempering in a range between 1000 and 1250 deg. F., depending on the physical properties desired. Double normalizing is sometimes used to obtain further improvement in the grain structure. With carbon on the high side of the specification, air-quenched castings show a Brinell hardness number of over 400 in 3-inch sections. This hardness is practically uniform throughout the section. Oil quenching is employed to produce higher hardness and depth of penetration, and even in a 4-inch section, a hardness number of over 500 Brinell is obtained.

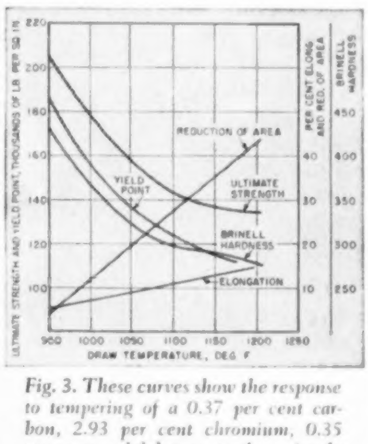


Fig. 3. These curves show the response to tempering of a 0.37 per cent carbon, 2.93 per cent chromium, 0.35 per cent molybdenum steel previously normalized from 1650 deg. F.

The steel also shows good response to tempering. After a normalize and a 1100 deg. F. treatment, it has a tensile strength close to 150,000 pounds per square inch, with an elongation value of about 12 per cent, and a Brinell hardness of about 300. When greater ductility is required, tempering should be done at higher temperatures. However, in such instances, some strength and hardness are sacrificed.

Fig. 4. Photomicrograph of 3 per cent chromium steel normalized from 1650 deg. F. and tempered at 100 deg. F. (X250). The pseudo-martensitic structure is well suited to resist abrasion.

Effect of Other Alloy Additions

Molybdenum in the range from 0.30 to 0.50 per cent will improve depth-hardening characteristics and aid in reducing susceptibility to temper brittleness in the lower temperature ranges. If the molybdenum-bearing steel contains relatively high carbon (0.40 to 0.60 per cent) additions of approximately 0.08 to 0.10 per cent vanadium provide greater uniformity in hardening. Small additions of silicon increase strength and hardness and this element is sometimes increased to 0.80 or 1.00 per cent. Manganese is added in amounts between 0.50 and 0.80 per cent.

Metallurgical Service Available

When you have occasion to produce castings for applications involving severe abrasion and wear, it will pay you to investigate the advantages of using 3 per cent chromium steel. If you need help on some specific metallurgical problem, be sure to consult one of ELECTROMET's specially trained metallurgists and engineers. For further information, write to the nearest ELECTROMET office: in Birmingham, Chicago, Cleveland, Detroit, Los Angeles, New York, Pittsburgh, or San Francisco. In Canada: Welland, Ontario.

The term "Electromet" is a registered trade-mark of Union Carbide and Carbon Corporation.

Correspondence

Strikes a Blow for Hammers

ERIE, PA.

The story in the March 1953 issue regarding the Editor's visit to the Babcock & Wilcox plant at Beaver Falls, Pa., was very interesting. However, I winced a bit at the statement on p. 89: "It is obvious, therefore, that the engineering staff would be interested in any device which would eliminate the hammer and press." Apparently you are saying that the hammer is a necessary evil and I do not quite know whether to be flattered that you find it necessary, or offended because you think it evil. Perhaps what really hurts is your belief that it should be so obvious that anyone who is so unfortunate as to have to use a hammer is bound to be interested in any equipment that could replace it.

Hammers, you know, are our bread and butter, and sometimes the frosting on our cake. They may have their faults, but they do apply forces that cannot be controlled and delivered by any other machine. We build some hammers three times the size of the one at Babcock & Wilcox and yet that hammer, working on some of the tough alloys that it forges, probably strikes a blow approaching the tonnage of the largest press working in this country today.

MACDONALD S. REED
Vice-President
Erie Foundry Co.

Oh, for Words Untrammeled!

Pity the poor editor! He can't say much of anything in praise of something without running the risk of hurting somebody else's feelings, either directly or by implication.

My intention in writing about the continuous casting at Beaver Falls was not to throw bricks at the hammer doing yeoman service in reducing the small ingots from the electric furnace department to billet size, so much as to indicate that the new method of casting a billet direct would eliminate an expensive intermediate operation. In this event, the hammer would suffer from what labor leaders call "technological unemployment". I certainly can sympathize with the worries and troubles that technological unemployment involves, but I am thoroughly convinced that such dislocations are relatively transient since engineering progress results in *more* jobs rather than fewer – not only for workmen but for steam hammers.

THE EDITOR

Reconsiders Criticism

ERIE, PA.

In the light of the Editor's explanation, I apparently missed the point the first time, perhaps because the reader's mind was not as alert as the writer's, or perhaps because I am sensitive to criticism of hammers. However, I did not have a chip on my shoulder.

I quite agree with the Editor that if some way can be found to do the job better than it is now being done, it will broaden the field for work that can be done better with hammers than in any other manner. If the continuous casting process eliminates the need for reducing ingots to billets, I think that it will displace more rolling mills than it will hammers. Incidentally, I do not know enough about the process to know whether the cast billet is equal to the rolled or forged billet in grain structure, or whether it is still essentially a casting which must be worked in order to develop desirable properties.

MACDONALD S. REED
Vice-President
Erie Foundry Co.

Chromium-Plated Cylinder Bores

OLEAN, N. Y.

In the report of the Woodside Lecture "A Research Engineer Looks at Metallurgy" in April *Metal Progress*, Mr. Rosen appears to minimize what to us is an important phase of metallurgy as applied to diesel engines.

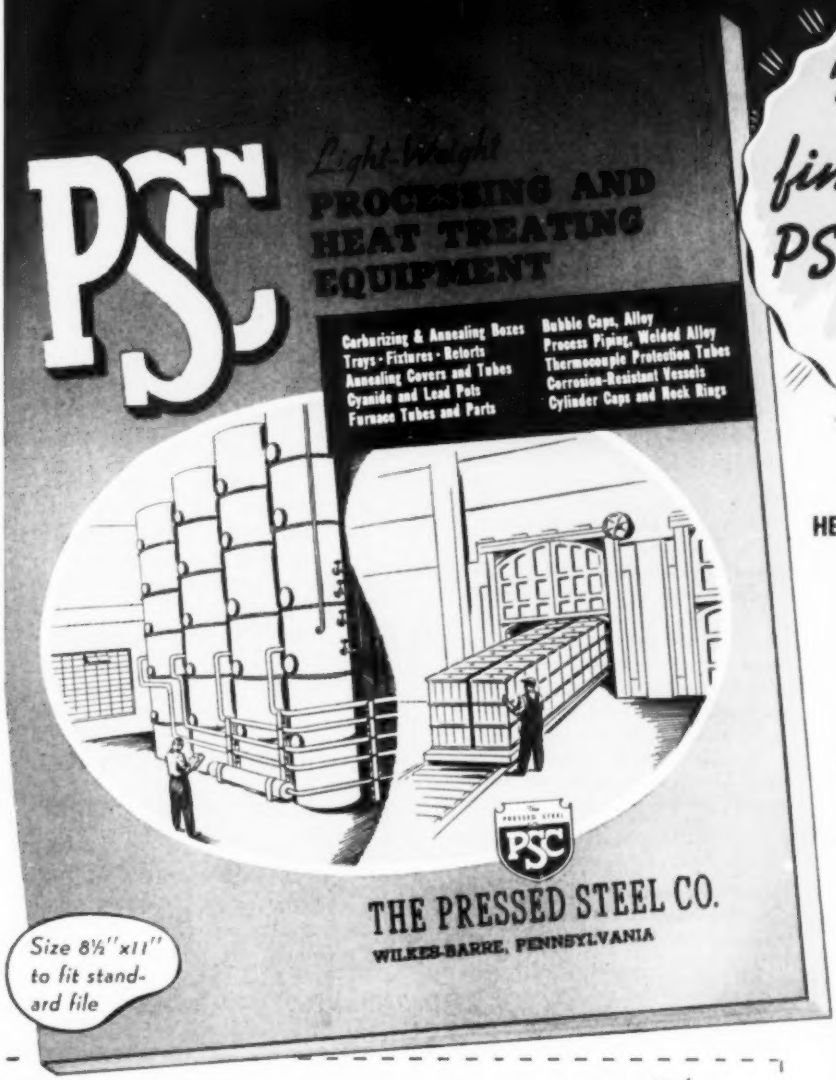
He states (p. 194): "Some trials have been made with chromium-plated cylinder surfaces, but the manufacturing processes have been so difficult as to warrant chromium-plated piston rings only when they operate against induction hardened cast iron. This combination has been sufficiently encouraging to warrant production."

This quotation infers that chromium plating

(Continued on p. 110)

IF YOU USE SHEET ALLOY EQUIPMENT IN ANY OF THESE 30 CLASSIFICATIONS

You will find the new PSC CATALOG helpful



The Pressed Steel Company
713 N. Penna. Ave., Wilkes-Barre, Pa.

Sign · Tear Out · Mail

Send us a copy of your catalog on welded alloy equipment for heat-treating, oil refining, and processing of chemicals, drugs, foods, etc.

Name..........

Company..........

Address..........

INDUSTRIAL EQUIPMENT OF HEAT AND CORROSION-RESISTANT SHEET ALLOYS

CLASSIFICATIONS OF PSC HEAT AND CORROSION-RESISTANT INDUSTRIAL EQUIPMENT

Baskets, annealing & carburizing
Baskets, cyanide dipping
Baskets, pickling
Bends, alloy pipe & tubing (welding)
Boxes, annealing & carburizing
Caps, bubble (fractionating tower & still)
Caps, cylinder (compressed gas)
Covers, annealing (Bell furnace)
Covers, annealing (elevator furnace)
Fixtures, carburizing
Flights, conveyor (syn. rubber plant)
Headers, air pre-heating
Manifolds, gas exhaust
Muffles, carburizing
Piping, process (alloy only)
Pots, carburizing & annealing
Pots: lead, cyanide & salt
Racks, annealing & carburizing
Racks, sheet pickling
Retorts, carburizing
Rings, neck (compressed gas cylinder)
Tanks, copper annealing
Tanks, pickling
Trays, annealing & brazing
Tubes, annealing
Tubes, furnace vent
Tubes, radiant furnace
Tubes, thermocouple protection
Tubing, corrosion & heat resistant
Tubing Assemblies, welded alloy

Unusual IS THE WORD FOR THESE STAINLESS STEEL BLANKS . . .

Not Unusual IN PRODUCTION AT . . .

No matter how you look at it, these heavy gauge Blanks are unusual.

Unusual because they are made of Type 302 stainless steel. Unusual because they are 5" thick x 7¾" ID x 78½" OD and weigh approximately 7000 pounds each. Unusual because each required special cutting and machining to produce its rough machined shape. But such jobs are *not unusual* at G. O. Carlson, Inc.

As specialists in working stainless steel, Carlson provides an unique service for you

. . . by having skilled workers produce your stainless shapes.

. . . by making full use of the specialized cutting and machining equipment at Carlson.

. . . by giving you exactly what you want "on time" to keep your production running smoothly.

. . . by eliminating shipping charges on material you cannot use.

Put your stainless steel plate requirements in good hands . . . that means, G. O. Carlson, Inc.

Stainless Steels Exclusively

G. O. CARLSON, INC.

PLATES • FORGINGS • BARS • SHEETS (No. 1 Finish)

THORNDALE, PENNSYLVANIA

District Sales Offices in Principal Cities

Plated Cylinder Bores

(*Continued from p. 108*)

of cylinders (internal surfaces) because of difficulty isn't too practical. If this statement were made 20 years ago it would be true. Today, however, chromium (porous type) plays an important role in the modern high-output diesel engine.

To give some idea of the wide acceptance of this process, several locomotive builders incorporate cylinders lined with porous chromium in their diesels. In both the Army and Navy Air Forces all aircraft engine cylinders are chromium plated on first overhaul. The U. S. Navy has a specification covering the application for marine diesels.

Porous chromium also has double-barreled advantages for the large diesel users such as the U. S. railroads. It not only prolongs cylinder life three to five times, but it eliminates oversizing. After a liner has worn to its condemning limit, its bore can be "re-chromed" back to standard size. The majority of Class I railroads have been enjoying these benefits for several years.

So chromium for engine cylinders is not exactly new.

WILLIAM J. FRITTON
Vice-President and Sales Manager
Van der Horst Corp. of America

Original Version of Statement on Same

PEORIA, ILL.

With reference to Mr. W. J. Fritton's remarks concerning certain statements appearing in the printed version of my William Park Woodside Lecture, the following comments should be emphasized:

The article appearing in the April 1953 issue represents a condensed and editorially shortened version of the original Woodside Lecture which I presented in Detroit on Oct. 13, 1952; an editorial footnote to this effect probably would have cautioned readers in drawing conclusions on specific points. Mr. Fritton points to a statement in the published version pertaining to the use of chromium-plated cylinder surfaces.

I am quoting this same paragraph as it was originally presented in the complete version of the Woodside

(*Continued on p. 112*)

PRODUCT—
Flight instrument part
MATERIAL—
Aluminum alloy
EQUIPMENT—
85 kv. x-ray machine

What's the right X-ray Film?

KODAK INDUSTRIAL X-RAY FILM, TYPE A

Soundness of this die-cast part is essential to dependable accuracy in an aircraft flight instrument. So each casting is radiographed.

For the exposures, the radiographer uses 85 kv., 35 secs., a tube distance of 30 inches, and Kodak Industrial X-ray Film, Type A—the right film for this combination of radiographic factors.

THERE'S A RIGHT FILM FOR EVERY PROBLEM

Whatever your radiographic problem, you'll find the best means of solving it in one of Kodak's four types of industrial x-ray film. This choice provides the means to check castings and welds efficiently, offers optimum results with varying alloys, thicknesses and radiographic sources.

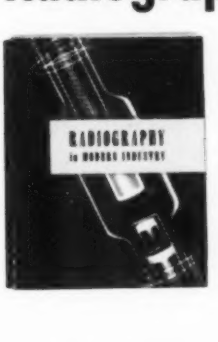
Type A—has high contrast and fine graininess with adequate speed for study of light alloys at low voltage and for examining heavy parts at intermediate and high voltages. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltages and for much million- and multi-million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage, without use of calcium tungstate screens.

Radiography . . . another important function of photography

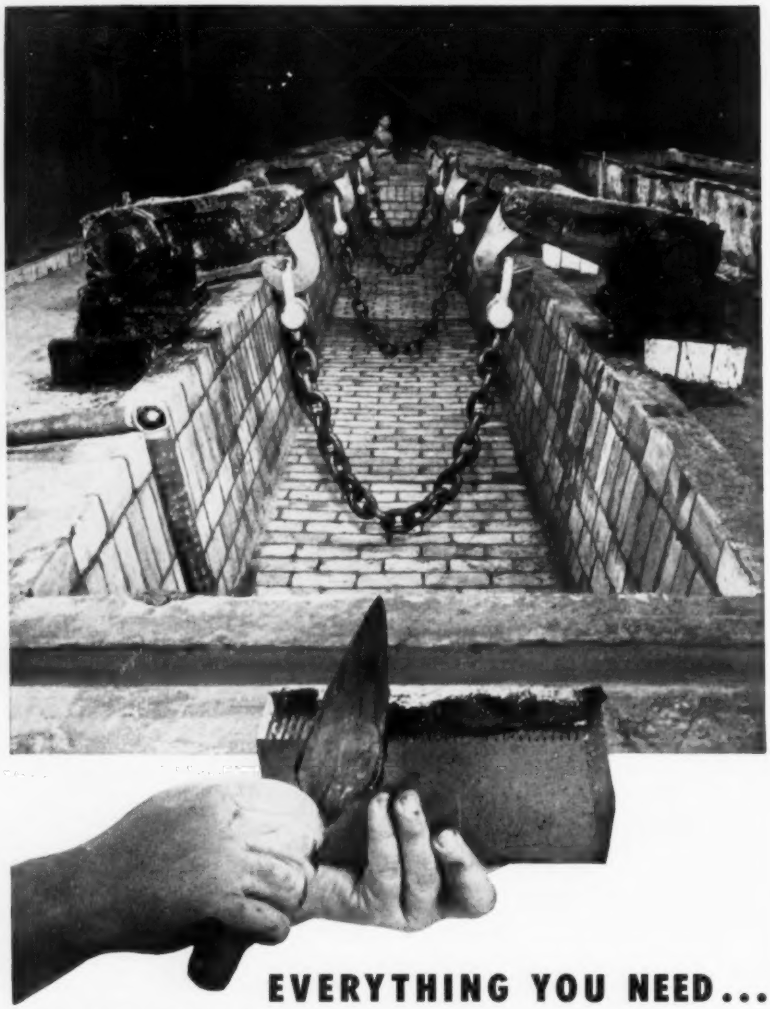


RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get a copy from your local x-ray dealer—price, $3.

EASTMAN KODAK COMPANY
X-ray Division . Rochester 4, N. Y.

Kodak
TRADE MARK



EVERYTHING YOU NEED...
OR MAY NEED ... in a corrosion-proof cement

LOOKING beyond present needs, your unforeseen or future requirements are fulfilled by Atlas ALKOR® 5E. This one furane resin cement resists acids, alkalies, salts, greases, solvents and oils at temperatures to 380° F. . . . providing a range of protection you should have against unforeseen factors or eventual process changes.

And, you have long-term protection with ALKOR 5E. By every accepted test, ALKOR 5E has proved superior in both physical and chemical properties . . . as well as in important considerations of use. ALKOR 5E is safe to install. *It will not contribute to skin disorders . . . and has no objectionable odor.*

ALKOR 5E HAS NO EQUAL

ONLY ALKOR 5E combines *low shrinkage* that means level joints . . . *high adhesion* to brick of over 700 psi . . . *long working time* that cuts material waste . . . *fast setting time* for practical use . . . with *virtually universal resistance* to corrosion.

FOR COMPLETE FACTS, send for Bulletin 5-2.

ATLAS PRODUCTS STAND
... between your process and corrosion

ATLAS MINERAL PRODUCTS COMPANY
MERTZTOWN PENNSYLVANIA

Engineering Representatives Throughout the United States

Original Version

(Continued from p. 110)

Lecture, before editorial methods were applied:

"Other efforts have been made to utilize chromium-plated cylinder surfaces. The manufacturing process and the techniques of control in high-production cylinders have been sufficiently difficult to warrant the utilization of chromium plating on the piston rings only when operating with induction hardened cast iron. The advantages of this combination have been sufficiently encouraging to warrant continuation of this practice in production."

C. G. A. Rosen
Consulting Engineer
Caterpillar Tractor Co.

More on Titanium Sticking to Indenter

Chicago

After two years of testing the hardness of titanium, our observations have led to the conclusion that titanium does adhere to the indenter. A Tukon microhardness tester with a 100-g. load was used for test purposes. The Vickers diamond pyramid (136°) was used as an indenter.

Observations indicated that sticking did not occur until several thousand impressions had been made. The indentations were no longer clean-cut, but rather rough and irregular in shape. Microscopic examination revealed the presence of adhering titanium metal.

The diamond point was cleaned by "peeling" the titanium metal with a razor blade, and the indenter was again useful for at least several thousand more impressions.

In line with Mr. Grodzinski's recommendation for a high polish (*Metal Progress*, May 1953, p. 116), it is noted that during the course of this work several new indenters were purchased. Sticking, however, occurred on these new indenters after several thousand impressions. This may be due to the inherent quality of titanium to seize and gall.

R. W. Hanzel
Associate Metallurgist
Armour Research Foundation
of Illinois Institute of Technology

— another instance where

Superior Stainless *shines!*

The stainless steel windshield wiper on your car does a sparkling job when the going is wet . . . stays bright and rustless over years of exposure to the worst of weather . . . and is very likely to be made of SUPERIOR Stainless Strip Steel. As original equipment on a variety of cars, and sold by thousands of service stations, garages, car dealers and supply stores, windshield wiper arms and blades of Superior Stainless highlight in service the quality of their metal. ● Can we help you with *your* projected applications?

Superior Steel

CORPORATION

CARNEGIE, PENNSYLVANIA

A 31-TON INGOT *SLICED* IN 35 MINUTES!

Going . . . going . . . gone! You can actually see the torch move as the lance of flame whips through the 62,500 pound steel ingot. In 35 minutes, the cropped section drops from the smoothly-trimmed ingot, now 21,524 pounds lighter. The Airco No. 6850 heavy duty torch makes an exact cut so that forging is within a specified weight. Sections from one foot to a full 6 feet in diameter! Tips are available for acetylene and other fuel gases. For details, get in touch with the nearest Airco office.

Remember, when you need oxygen, acetylene, other industrial or rare gases, think of Air Reduction. A nation-wide distribution system is ready to supply your needs.

AIRCO ®

DEALERS AND OFFICES IN MANY PRINCIPAL CITIES

AIR REDUCTION

60 East 42nd Street • New York 17, N. Y.

Air Reduction Sales Co. • Air Reduction Magnolia Co. • Air Reduction Pacific Co.

Represented Internationally by Airco Company International

Divisions of Air Reduction Company, Incorporated

at the frontiers of progress you'll find

AN AIR REDUCTION PRODUCT

superfine finish
eliminated buffing
on these parts

For the temple bow illustrated, Sunware Products Inc., New Britain, Connecticut, makers of Rayex Sun Glasses, formerly used ordinary drawing brass and finished this part by hand buffing—one at a time.

This was a costly procedure, so a switch was made to Formbrite* . . . then a happy thought occurred:

With Formbrite's superfine grain structure and added surface hardness, why not *tumble* these bows—by the thousands.

It was as simple as that. Formbrite's clean, smooth surface produced a jewelry finish—ready for gold-plating and lacquering. Since these bows are produced by the millions, the savings effected were substantial.

Formbrite, just in case you haven't heard, is a superior drawing brass. Comparative tests prove conclusively that the superfine grain structure of this specially processed forming brass means stamped and formed products that are stronger, harder, "springier" and more scratch-resistant. Yet the metal is so ductile that it can be readily formed, drawn and embossed.

Time studies made of finishing operations have shown that a bright, lustrous finish ordinarily can be obtained by a simple "color buffing" operation—or by tumbling, if the product lends itself to this method.

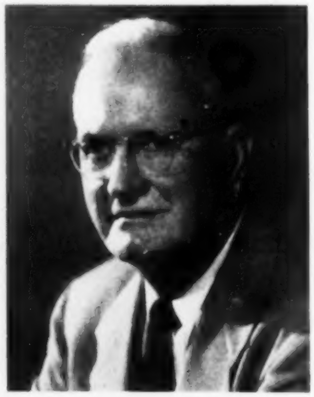
And yet, Formbrite costs no more. Convince yourself that Formbrite is the metal for your product. Write for Publication B-39. Address The American Brass Company, General Offices, Waterbury 20, Conn. In Canada: Anaconda American Brass Limited, New Toronto, Ontario.

*Reg. U. S. Pat. Off.

an ANACONDA Product made by The American Brass Company

Personal Mention

Curry M. Carmichael



Clark B. Carpenter

Curry M. Carmichael, past-trustee, has retired from active duty as head of the stainless steel and alloys division of Shawinigan Chemicals, Ltd., Montreal, Canada, but remains as consultant and member of the board of directors. His experience in electric furnace work dates back to youthful years (World War I) in a small plant at Anniston, Ala., near his birthplace, making "synthetic pig iron" from scrap. Later he was employed by Electro Metals, Ltd., becoming superintendent of the ferro-alloy plant which is now Electro Metallurgical Co. of Canada, at Welland, Ontario. In 1930 he joined Shawinigan Chemicals Ltd. and has resided in Montreal for many years. Among his duties have been the general supervision of the Company's modern foundry at Shawinigan Falls, Quebec, which specializes in stainless steels and high alloys, not only for own use for chemicals manufacture, but for custom castings. It was recently expanded to manufacture jet engine parts. Mr. Carmichael writes: "So far I seem to be busier than before, but without the pressure!"

Manuel Goldman has left Battelle Memorial Institute to accept a position as a metallurgist in the technical service department of Goodyear Aircraft Corp., Akron, Ohio.

Clark B. Carpenter, head of the metallurgy department and dean of the graduation school at the Colorado School of Mines in Golden, retired this summer. Prof. Carpenter was accorded the rank of professor emeritus after his retirement. He has served on the Mines faculty since 1920 and has been a full professor since 1936. One of the best-known metallurgists in the country, he spent two months last year in Great Britain as guest lecturer at the Royal School of Mines in London. He received a B.Sc. degree in mining from the University of Kansas in 1915 and a M.Sc. degree in mining from the Massachusetts Institute of Technology in 1922. Prof. Carpenter has served as a consulting metallurgist for several companies, and prior to his coming to the Colorado School of Mines, he was associated with the Anaconda Copper Mining Co. and the Colorado Fuel and Iron Corp. He served as a lieutenant in the U. S. Army engineers from 1917 to 1920. He is a member of the American Institute of Mining and Metallurgical Engineers and the American Foundrymen's Association and other professional societies, and has written articles for *Mines Magazine*, the *Colorado School of Mines Quarterly*, and *Compass*, a publication of Sigma Gamma Epsilon, professional engineering fraternity.

L. M. Nieliwocki has been promoted to the position of assistant technical superintendent at the Belle Works, a duPont plant near Charleston, W. Va. He joined duPont in 1946 at their Sabine River Works plant in Orange, Tex., as an assistant metallurgist. In 1950 he was appointed senior metallurgist.

Edward H. Platz, Jr., manager of alloy sales at the Lebanon Steel Foundry, Lebanon, Pa., was awarded a Certificate of Service by the Department of Commerce, Washington, D. C., for his service as commodity industry specialist, in the iron and steel division of the National Production Authority. Mr. Platz served the N.P.A. for six months on loan from Lebanon Steel.

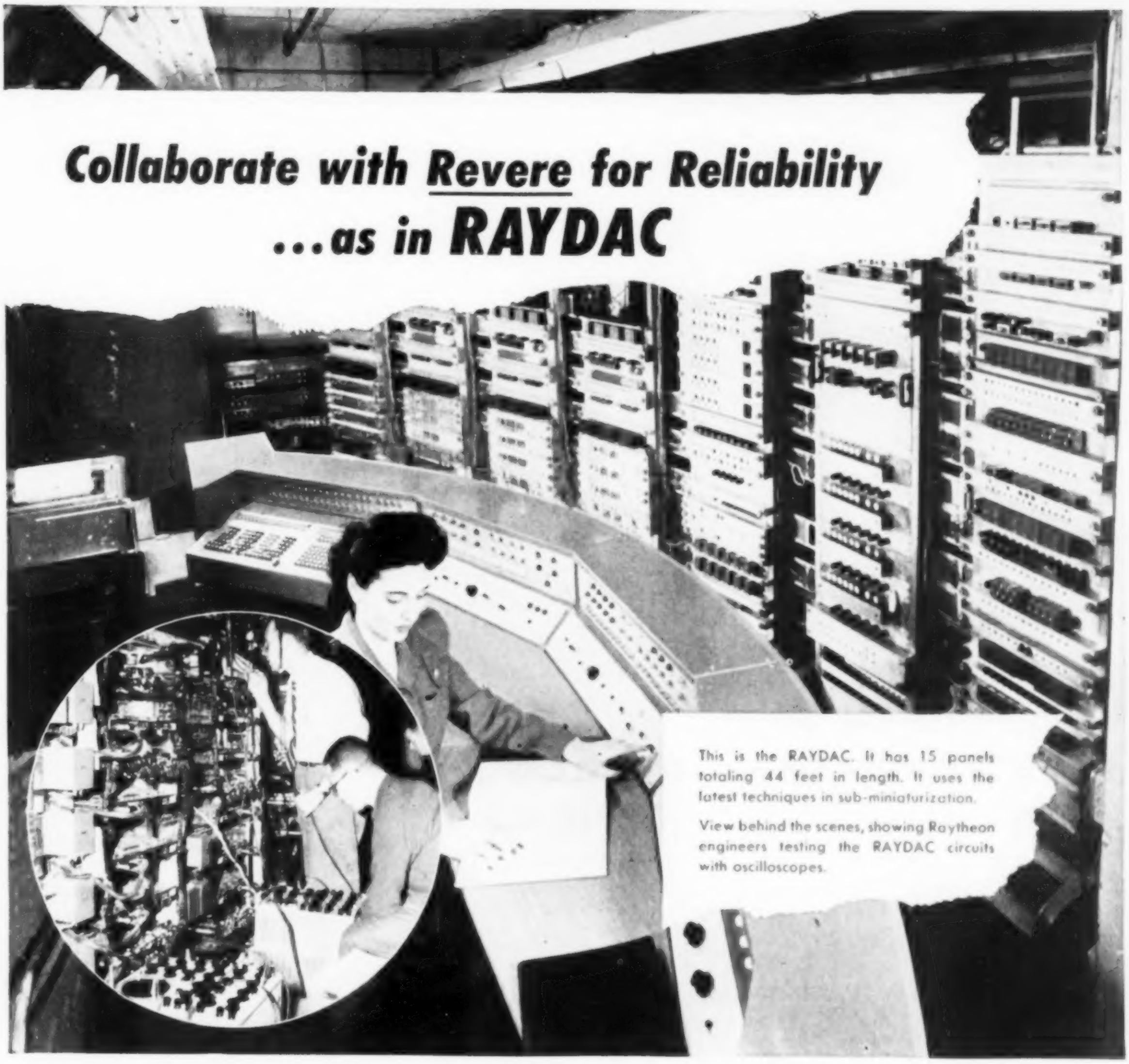
A. Ward Jenks has been appointed Detroit district manager of the Pittsburgh Crucible Division, Crucible Steel Co. of America. He joined Crucible in 1944 as manager of the forging blanks department and in his new capacity will continue his close connection with that department. Mr. Jenks replaces **W. W. Noble**, who was district manager until his retirement on May 1st. Mr. Noble has been connected with the Crucible sales division since 1922 in the capacity of district manager at Cleveland, Pittsburgh, and Detroit.

Joseph C. Abeles has been appointed vice-president and sales manager of Kawecki Chemical Co., Inc., Boyertown, Pa., and will make his headquarters in New York as of June 1st. For the past 17 years he has been associated with Faesy & Besthoff, Inc., New York.

John B. Florance has been appointed chief engineer of James H. Knapp Co., Los Angeles. He has been with the company for many years, having served through all engineering positions up to his present position as chief engineer.

James F. Hetz has been appointed a sales representative in the Ohio territory for the Park Chemical Co., Detroit, manufacturers of heat treating materials. He will make his headquarters in Cincinnati, Ohio, where he has been connected with the heat treating business for the past ten years.

Collaborate with Revere for Reliability ...as in RAYDAC



This is the RAYDAC. It has 15 panels totaling 44 feet in length. It uses the latest techniques in sub-miniaturization.

View behind the scenes, showing Raytheon engineers testing the RAYDAC circuits with oscilloscopes.

RAYDAC means Raytheon Digital Automatic Computer, developed by the Raytheon Manufacturing Company, Waltham, Mass., for the Navy's Bureau of Aeronautics. It is an "intelligence center" to help analyze the behavior of missiles during test flights. Its importance is indicated by the fact that in a matter of minutes it can perform the calculations involved in analyzing a single missile flight, a task that would take a team of mathematicians from 20 to 30 days. The Raydac thus speeds up tremendously the development and testing of such missiles. It contains enough tubes and germanium diodes made by Raytheon, for more than 1,000 home radio sets.

In such a complicated electronic computer reliability is essential. This is achieved through design, the choice of the best materials and components, and meticulous manufacture. Revere during the past 10 years has collaborated closely with Raytheon, working out proper specifications for materials, as for example, OFHC copper. Raytheon engineers and production men have visited Revere laboratories at New Bedford, Mass., and Rome, N. Y., and many Revere specialists have studied methods and processes in the Raytheon plants and laboratories. These hand-in-glove contacts, many of them highly confidential, have proved their value.

The same kind of collaboration is open to you, and will be especially useful and time-saving if begun as soon as you have a new project on your boards. To obtain it, simply get in touch with the nearest Revere Sales Office. See your telephone book or write direct.

REVERE
COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere

SEE REVERE'S "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

LET THIS NEW WESTINGHOUSE CATALOG INCREASE X-RAY EFFICIENCY

Better, cheaper, faster radiographic testing is a product of trained personnel plus proper equipment.

The new Westinghouse Industrial Supplies and Accessories Catalog has 44 pages listing over 600 items of film, chemicals, equipment, tools, and devices. The advantages and uses of each product are carefully explained.

In initiating, expanding, or refurbishing your radiographic program, call your nearest Westinghouse X-ray office (listed in the catalog or your phone book). There you will find men of wide experience who can help you toward an efficient, modestly priced arrangement.

Use the coupon or call your Westinghouse X-ray representative for a copy. It means faster, cheaper, better radiographs.

YOU CAN BE SURE...IF IT'S Westinghouse

Westinghouse Electric Corporation
X-ray Division, Industrial Application, Dept. 0.66
2519 Wilkens Avenue
Baltimore 3, Maryland

Gentlemen: —

Please send me a copy of the new booklet "Industrial X-ray Supplies and Accessories."

Name ______ Title ______

Company ______

Street ______

City ______ Zone ______ State ______

J-08266

Personals

Paul N. Falkenhagen ⊕ has left his position with Douglas Aircraft Co., Inc., Tulsa, Okla., and is now with Wolfe Engineering Service Co., Inglewood, Calif., as a sales engineer for Franklin C. Wolfe Co. and Mathewson Co.

Earle Thall ⊕, formerly metallurgist at John Inglis Co., Toronto, Canada, is now with Radio Corporation of America, Harrison, N. J., as a metallurgical engineer in the design and development section.

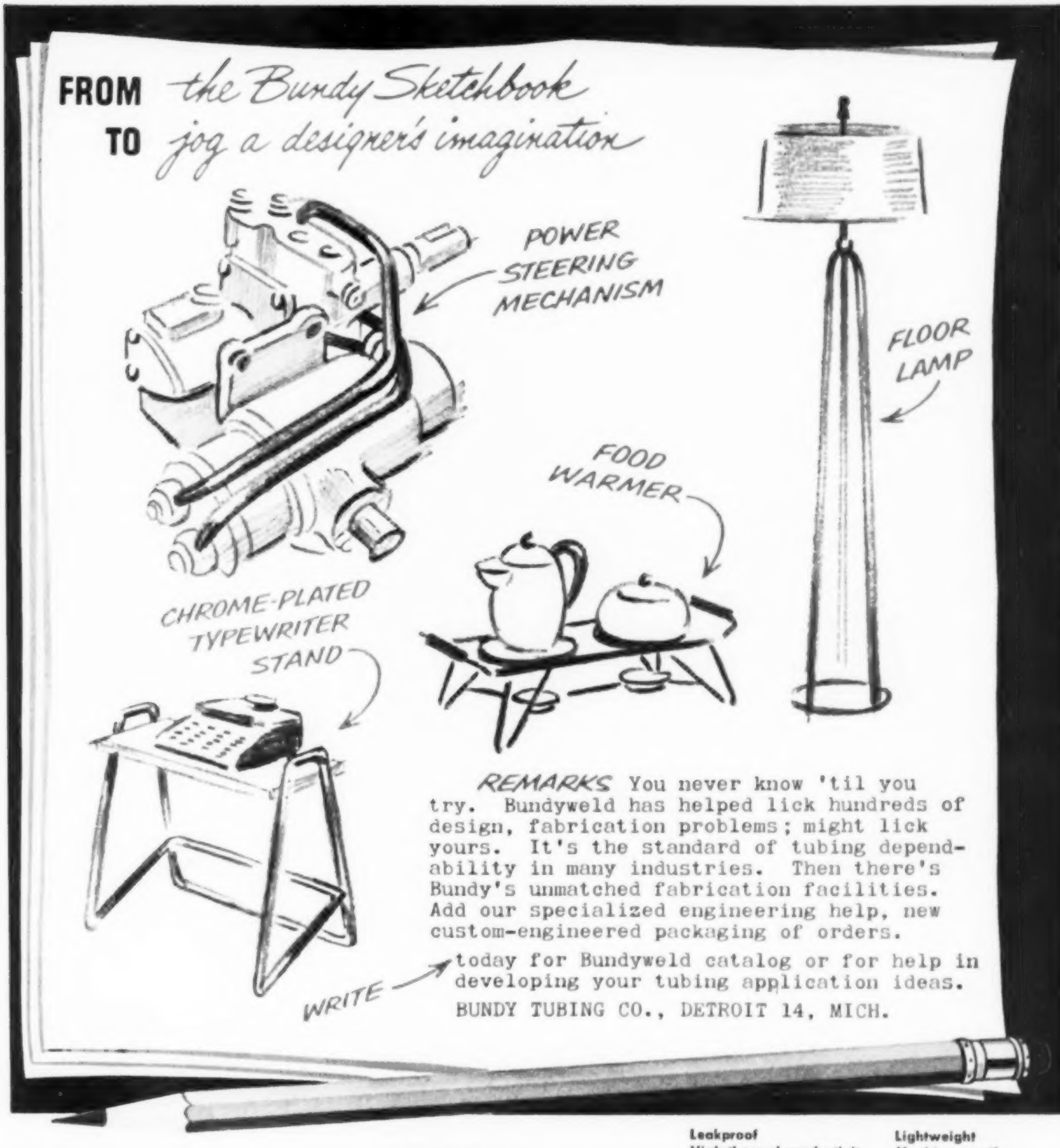
Perry L. Holsinger ⊕ has been recalled to duty with the U. S. Navy for two years and is assigned as a pilot in an attack squadron now based in Jacksonville, Fla.

E. H. Horstkotte ⊕ has been appointed engineering consultant for the Schenectady, N. Y., area by Michigan Oven Co., Detroit, builders and designers of industrial ovens. Mr. Horstkotte retired from General Electric Co. earlier this year after 40 years' service. During approximately half of this period his work was devoted to the application and development of electrical equipment used in the paper, cement, woodworking and steel furnace industries. For the last twenty years he was engineer of the laboratory at the Erie Works. In addition to this activity, during the postwar period he supervised all the planning and construction of the locomotive and car equipment development laboratory.

William J. Little, Jr., ⊕, for twelve years in the metallurgical department of National Tube Division, U. S. Steel Corp., McKeesport, Pa., has resigned to accept a position as research metallurgist with the International Nickel Co., Inc., Huntington, W. Va.

Alan V. Levy ⊕ was recently made chief process engineer in charge of the material and process group at Marquardt Aircraft Co., Van Nuys, Calif.

R. R. LaPelle ⊕ has been transferred from Springfield, Mass., where he was industrial heating specialist, to the Westinghouse Electric Corp.'s Meadville (Pa.) Works where he is serving as an advisory engineer in the industrial heating applications engineering section.



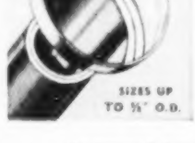
Bundyweld Tubing

® DOUBLE-WALLED FROM A SINGLE STRIP

- Leakproof
- High thermal conductivity
- High bursting point
- High endurance limit
- Extra-strong
- Shock-resistant
- Ductile
- Lightweight
- Machines easily
- Takes plastic coating
- Scale-free
- Bright and clean
- No inside bead
- Uniform I.D., O.D.

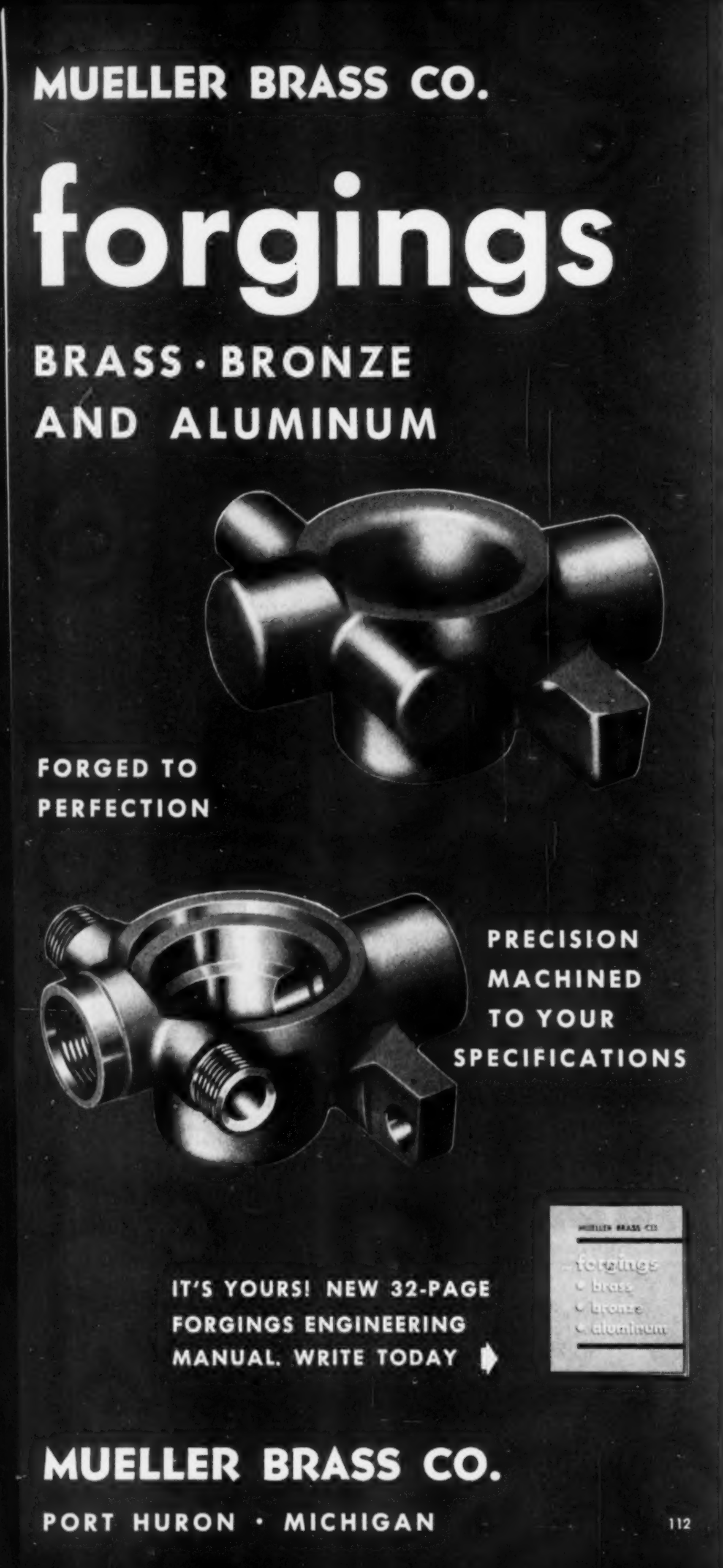
WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.



← NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave. South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**



Personals

A. F. Davis, vice-president and secretary of Lincoln Electric Co., Cleveland, Ohio, has been elected president of the Alumni Association of Ohio State University for a two-year term. The association's 25,000 members are said to be the largest alumni organization among the Big Ten Conference schools. Mr. Davis graduated from Ohio State in 1913 with a degree in electrical engineering and has been an ardent supporter of the University. He established and has developed there the A. F. Davis Welding Library which is the largest and most complete collection of material on welding anywhere in the world.

Mervin S. Allshouse, Jr., was recently released from active duty with the Navy and has joined the Amplex Mfg. Co. (division of Chrysler Corp.), Detroit, as a laboratory engineer, metallurgical.

J. D. Dickerson, formerly chief metallurgist, Republic Steel Corp., Buffalo, N. Y., has accepted the position of chief metallurgist at the Midland (Pa.) plant of Crucible Steel Co. of America.

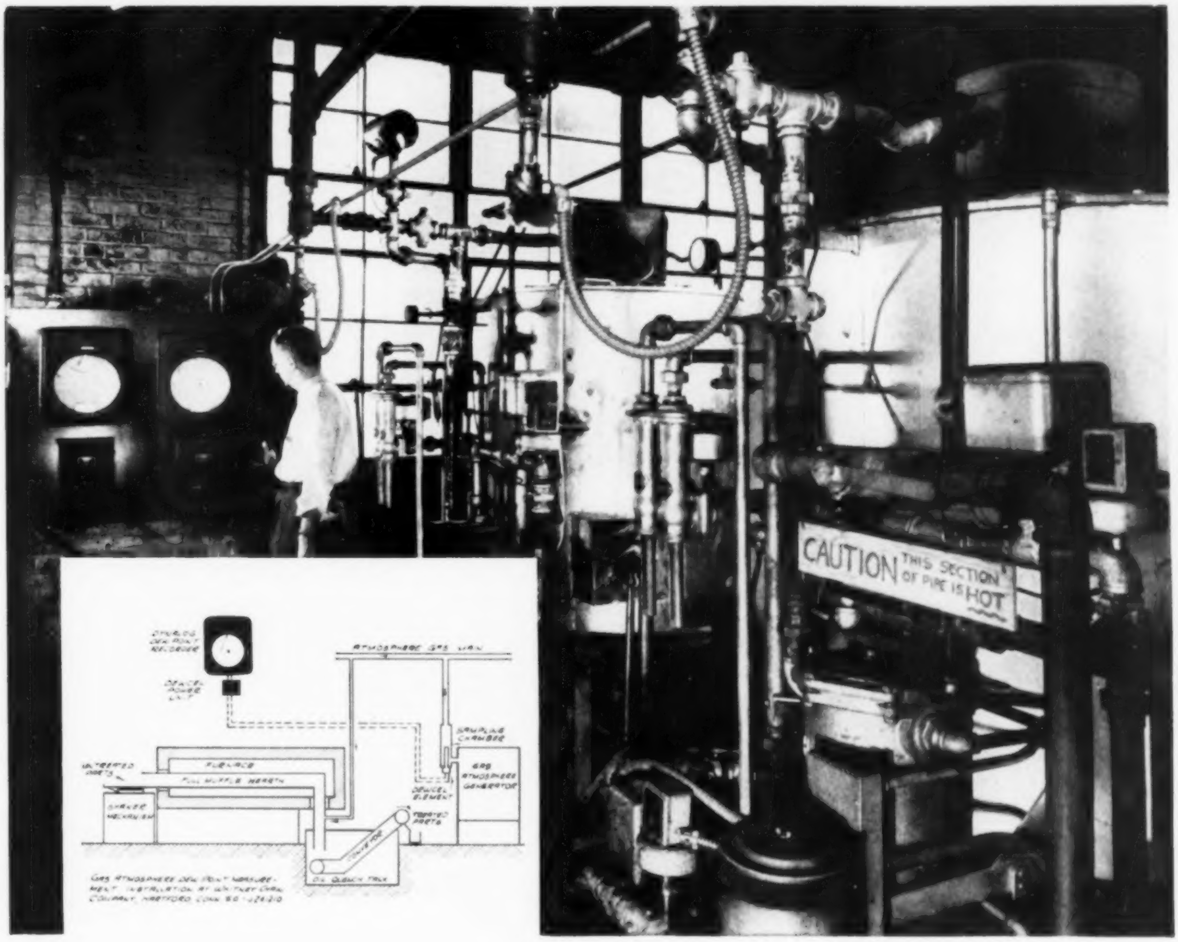
Harold F. Lathrop, previously engineering supervisor, specialty refrigeration products, General Electric Co., Erie, Pa., is now design engineer, Amana Refrigeration, Inc., Amana, Iowa.

William Whitfield, formerly foreman at the blooming mill of Republic Steel Corp.'s Warren, Ohio, plant, is now occupying a similar position at Lone Star Steel Co., Lone Star, Tex.

Merritt E. Langston, who obtained an M.S. degree in metallurgical engineering from the Missouri School of Mines last year, is now serving with the U. S. Army in Munich, Germany.

Thomas A. Kilburn, formerly associated with Aluminum Co. of America's research laboratories in New Kensington, Pa., has accepted a position as a research metallurgist with Chrysler Corp., Detroit.

Walter T. Miller is now with Bohn Aluminum & Brass Corp., serving as sales representative from the Chicago district office.



How Whitney Chain Improved Heat Treating with **DEWCEL*** Moisture Measurement

Whitney Chain Co., in Hartford, Conn., uses two Gas-Atmosphere Generators to supply a battery of heat treating furnaces in producing chain plates, pins, rollers, and bushings for their Power Transmission and Conveyor Chains. Correct atmosphere conditions in the furnaces must be maintained for proper carbon control and retention of finish on these hardened and carburized parts.

Formerly it was necessary to make complicated time-consuming spot checks of these conditions. Now, *Foxboro Dew Point Recorders* monitor continuous samples of the gas from the generators . . . provide continuous dew point records which permit the operator to maintain desired gas quality.

The heart of this precise measuring system is its humidity-sensitive element — the exclusive Foxboro Dewcel which senses the dew point temperature to within $\pm 1°$ F. . . . rapidly responds to any change in moisture content. Complete illustrated description of the Foxboro Dew Point Recording System is contained in Engineering Data Sheet 340-7. Write for copy.

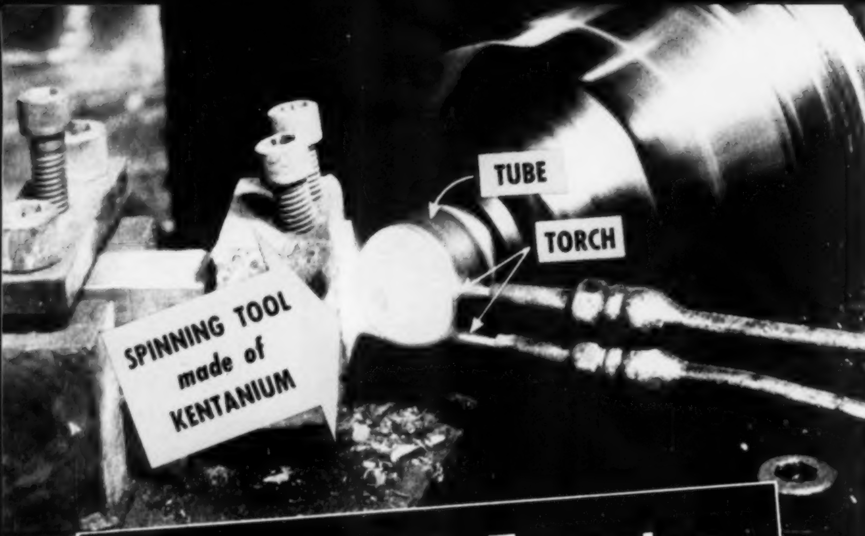
*Trade Mark

THE FOXBORO COMPANY, 527 NEPONSET AVE., FOXBORO, MASS.

FOXBORO
REG. U. S. PAT. OFF.

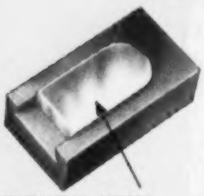
INSTRUMENTS that Improve Product Quality

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

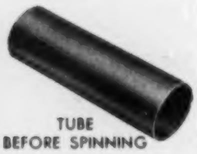


Outlasts 30 Tungsten Carbide Tools . . . When the HEAT (plus ABRASION) . . is On!

What's Your HOT Design Problem?



KENTANIUM INSERT



TUBE BEFORE SPINNING

TUBE AFTER SPINNING

This is a typical example of how industry effectively uses heat-resistant Kentanium to improve product performance under conditions of high temperature combined with oxidation and severe abrasion. Spinning the ends of hot steel tubing destroyed tungsten carbide tools in an average of 4 hours. Tools made of Kentanium last 15 hours before facing is necessary—and can be refaced up to 8 times per tool.

If improvement of your product or process involves high temperature conditions, especially where abrasion and oxidation are factors, investigate Kentanium. It is our exclusive development—chiefly titanium carbide (small percentages of other refractory metal carbides), with nickel "binder".

Great strength at temperatures up to 2200°F, and extreme resistance to abrasion, oxidation, and thermal shock are Kentanium's combination of features that cannot be obtained in any other known material. Weighs only 2/3 as much as steel; has hardness up to 93 RA; uses neither tungsten nor cobalt.

Kentanium is available in standard extruded shapes, simple molded forms, and intricate designs. Our engineers are available to work with you to apply it effectively to your high temperature problem.

An Exclusive Development of KENNAMETAL® Inc., Latrobe, Pa.

KENTANIUM

HEAT-RESISTANT, HIGH-STRENGTH, LIGHTWEIGHT CEMENTED TITANIUM CARBIDE

Personals

Raymond H. Hays, formerly with Caterpillar Tractor Co., is now assistant chief metallurgist at Ingersoll Products Division, Borg-Warner Corp., Chicago.

Paul Swraj has joined the family firm, M/S Amin Chand Payare Lal, in Calcutta, India, steel manufacturers and suppliers of pipes and pipe fittings.

Melvin E. Fields graduated from the University of Chicago School of Business with an M.B.A. degree in March, and is now assigned as administrative officer in the ANP Office of the Atomic Energy Commission in Washington, D. C. He is a major in the U. S. Air Force.

Robert E. Goddard, who received a B.S. degree in metallurgical engineering from Michigan College of Mining and Technology, has accepted a position with the American Brake Shoe Co., Chicago Heights, Ill., as a production trainee in the foundry. He has also been commissioned a second lieutenant in the U. S. Air Force Reserve and assigned to the Research and Development Command at Wright-Patterson Air Force Base, Dayton, Ohio.

A. Lesnewich, who recently received a Ph.D. degree in metallurgy from Rensselaer Polytechnic Institute, is now employed at Air Reduction Co., Research & Engineering Laboratory, Murray Hill, N. J.

H. William Parker resigned his position as assistant metallurgist at Taft-Peirce Mfg. Co., Woonsocket, R. I., and has accepted a position as metallurgist at Pitney-Bowes, Inc., Stamford, Conn.

Ralph R. West, president of West Steel Casting Co., Cleveland, was elected president of the Cleveland Engineering Society for the 1953-54 season. He has been a member of the Board of Governors for the past three years and becomes the Society's 70th president.

George D. Kneip, Jr., formerly with S. K. Wellman Co., Bedford, Ohio, has recently been appointed to the staff of the Oak Ridge National Laboratory, an atomic energy installation operated by Carbide and Carbon Chemicals Co., a division of Union Carbide and Carbon Corp.

Why Brass can better serve your needs
Economical
MACHINEABILITY
BRASS CASTINGS FILL THE SPECIAL REQUIREMENTS OF MANY MANUFACTURERS
The free cutting characteristics of Brass are ideal in the manufacturing of all types of valves, impellors, plumbing fittings and other castings that require machining. This adjunctive feature provides for lower tool maintenance costs . . . more rapid machining, which in effect leads to increased production.
FREE . . . Write for your copy of the 8-page Lavingot Technical Journal — Vol. 9, No. 1 — containing an article discussing "Silicon Bronze."
Specify—LAVIN NONFERROUS INGOT—Quality
Brass · Aluminum · Bronze · Zinc Base Die Casting Alloys
R. LAVIN & SONS, INC.
• Refiners of Brass, Bronze and Aluminum
• Producers of Zinc Base Die Casting Alloys
3426 S. KEDZIE AVENUE • CHICAGO 23, ILLINOIS
REPRESENTATIVES IN PRINCIPAL CITIES
R. LAVIN & SONS INC
1900
53 Years
1953
SERVING THE FOUNDRY INDUSTRY

you too can cut costs on heat treating small tools

furnace - quench tanks - furnace (corner) positioning

furnace - furnace - quench - tanks (side - by - side) positioning

furnace - quench tanks - furnace (side - by - side) positioning

do it with a Waltz small tool furnace

The compactness, plus versatility of this Waltz small tool furnace enables you to have heat treating facilities right in your own shop.

This Waltz set-up includes a pre-heat furnace, a high heat furnace and quench tanks in a unit designed for convenient positioning in your shop. Furnace sections equipped with casters. Temperature range permits treatment of all high speed steels including cobalt.

Waltz small tool furnaces are "money makers" in hundreds of shops throughout the country. Why not enjoy the lucrative advantages of heat treating facilities right in your own shop?

A complete line of Waltz standard or special heat treating furnaces, using all types of fuels, are built to suit your requirements.

Write for comprehensive bulletin. Dept. W

Waltz FURNACE COMPANY
SYMMES STREET
CINCINNATI, OHIO

Personals

John L. Goheen has been appointed district manager for commercial research on the West Coast by American Brake Shoe Co. His headquarters will be in San Francisco. Mr. Goheen joined the company as a research metallurgist in 1943. He served in the metallurgical research laboratories until 1950 when he transferred to market research and development work.

Robert E. Hopper has left Emsco Derrick Mfg. Co., Garland, Tex., and is now in business for himself as a metallurgical consultant in Dallas, Tex.

M. H. Binstock is now employed by Sylvania Electric Products Inc., Bayside, New York, as engineer in charge at the atomic energy division.

Wendell B. Wilson, formerly a physicist in X-ray diffraction at Battelle Memorial Institute, Columbus, Ohio, is now associated as a technical engineer with General Electric Co. at the aircraft nuclear propulsion project in Cincinnati, Ohio.

Donald R. Scheid has been transferred in the capacity of engineer from the Alloy, W. Va., plant to the Marietta, Ohio, plant of Electro Metallurgical Co., a division of Union Carbide and Carbon Corp.

Eric Ineson has been transferred from the London headquarters of the British Iron & Steel Research Assoc. to the new laboratories of the Association in Sheffield, where he is in charge of the laboratories of the metallurgy division.

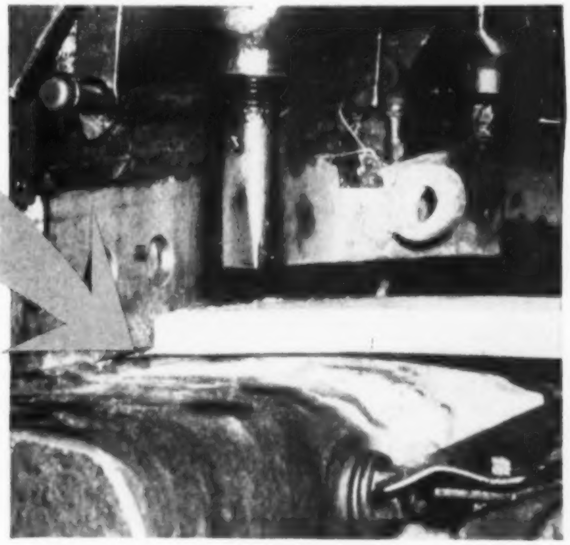
Robert P. Shimkus has resigned as metallurgist in the production engineering department at Goodyear Aircraft and is now secretary-treasurer of Barnes Commercial Body Co., Bronson, Mich., of which he is also one-third owner.

John W. W. Sullivan has been appointed metallurgical engineer of American Iron and Steel Institute, New York, succeeding **Charles M. Parker**, who was recently appointed assistant vice-president of the Institute in charge of its technical division. Mr. Sullivan had been active in metallurgical work for 18 years prior to becoming a member of the Institute staff in 1945.

A 3/32-in. deposit of HASTELLOY alloy C on the cutting edge of this shear blade has increased its life by four times. The edge can be rebuilt again and again, when it finally does wear.

HOT SHEAR BLADES STAY SHARP... when Hard-Faced with HASTELLOY Alloy C

TRADE-MARK



This shear blade is used in a plant producing tough non-ferrous alloys. Before hard-facing was adopted, the blades would chip, lose their edge, and have to be scrapped after shearing only about 50 tons of metal. They now can handle roughly four times that amount of metal because they are protected with HASTELLOY alloy C. They can be machined and hard-faced again when they finally do wear. One set of hard-faced blades has been in use in the plant for more than three years with periodic maintenance.

In steel mills, too, HASTELLOY alloy C has increased the life of blooming mill shears by as much as 10 times. Hard-faced blades have lasted 110 turns without maintenance.

HASTELLOY alloy C rod has also been applied to many other hot-working parts with outstanding success. The metal flows well by metallic arc welding or HELIARC welding without preheating. No peening is necessary. Deposits of HASTELLOY C work-harden in service. They can be machined by conventional methods.

For information on how to apply HASTELLOY alloy C to hot-working parts, write for a copy of "HAYNES Hard-Facing Manual." For on-the-job help in applying the rod, get in touch with the nearest District office.

HAYNES *Alloys*

TRADE-MARK

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles — New York — San Francisco — Tulsa

"Haynes," "Hastelloy" and "Heliarc" are trade-marks of Union Carbide and Carbon Corporation.

AMERICAN CHEMICAL PAINT COMPANY

AMBLER — CHEMICALS ACP PROCESSES — PENNA.

Technical Service Data Sheet

Subject: HOW GRANODRAW PHOSPHATE COATING FACILITATES COLD EXTRUSION OF STEEL

INTRODUCTION

By phosphate coating steel, prior to cold working it, extrusion, drawing, and other forming operations are greatly improved. In fact, it is the protective zinc phosphate coating that makes for the successful cold deformation of steel.

The tremendous pressures that most forming operations require produce extremely high frictional contact between die and metal. Without a protective coating, excessive galling (welding) of dies, breakage of tools, and unduly short die life will result. The combination of a non-metallic crystalline phosphate coating with an adsorbed lubricating film, possesses a low coefficient of friction while maintaining its stability under extremely high deforming pressures. This combination, therefore, greatly minimizes the aforementioned tool difficulties.

THE COLD EXTRUSION OF GENERATOR FRAMES

Cold extrusion is now being used advantageously in the manufacture of high production generator frames. This operation is facilitated by careful preparation and proper coating of the frame blank which is made from SAE 1010 open hearth plate steel.

After wheelabrating to remove the scale, the blank is rolled up and then fed automatically through a six stage dip wheel type washing machine which cleans the surface and applies the coating. The frame is then fed into an extrusion press where the wall thickness is increased on one end and reduced 47.5 percent on the other end. This operation produces concentric frames of uniform thickness and correct dimensions.

The Granodraw coating produces the proper surface to receive the lubricant by furnishing an extremely adherent film with the proper crystal size and continuity of coating required to insure maximum adsorbsion and tenacity by the lubricant. The lubricant, Montgomery DF 1101, is a combination of titre alkali soaps and resins. It is a powder which when dissolved in water and redeposited on the phosphate coated work piece, produces the necessary surface for subsequent operations. This film is dry and considerably less hydroscopic than similar coatings of the soap type. The concentrations of both the Granodraw and DF 1101 are maintained by simple chemical analysis.

PROTECTIVE COATING SEQUENCE

Stage	Operation	Chemical	Time	Temperature
1	Load and unload			
2	Cleaning	Tri-sodium phosphate and soda ash	1 Min.	180° F
3	Water rinse		1 Min.	180° F
4	Zinc phosphate coating	"Granodraw"*	4½ Min.	165° F to 180° F
5	Water rinse		2 Min.	180° F
6	Lubricating	H.A. Montgomery lubricant DF 1101	4½ Min.	190° F

*Trade Mark of the American Chemical Paint Company

CHEMICALS ACP PROCESSES

Corrosion of 18-8 in Oxidizing Solutions*

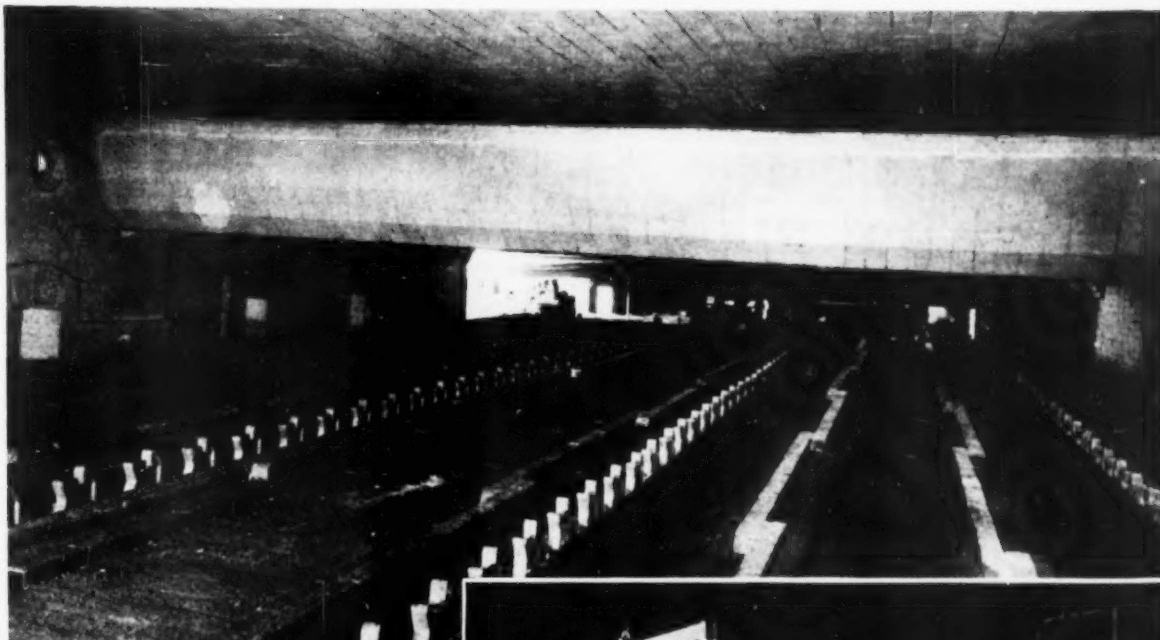
In a previous article on an investigation of the influence of nitric acid containing oxidizing agents on the corrosion of 18-8 stainless steel, it was established that, contrary to existing opinion, under certain conditions these steels have low corrosion resistance in oxidizing solutions. The present paper gives some results of an investigation of the influence of additions of the oxidizing agents $K_2Cr_2O_7$, NH_4VO_3, and KIO_3 to nitric acid on the electrode potentials and kinetics of the electrode processes on stainless steels.

Data were obtained on variations of the hydrogen scale, ε_H, at 18° C. (64° F.) in the range of times from 30 sec. to 24 hr. for 18-8 stainless containing molybdenum and columbium (Russian Type EI-403) in ten different solutions: 2.5*N* HNO_3 plus 0.1, 0.2, 0.5, 1.0, and 2.0*N* $K_2Cr_2O_7$; and 10*N* HNO_3 plus the same additions of $K_2Cr_2O_7$. The additions of $K_2Cr_2O_7$ increased the initial values of ε_H, compared to values for the nitric acid solutions, by 300 to 500 millivolts. For 2.5*N* HNO_3 the initial values of ε_H were 950, 970, 1000, 1020, and 1050 millivolts with increasing $K_2Cr_2O_7$ content. For 10*N* HNO_3 the initial value of ε_H was 1100 for 0.1*N* $K_2Cr_2O_7$ and about 1150 for the remaining solutions. In every instance the ε_H values rose with increasing time, rapidly at first and then more slowly, and after 24 hr. were about 150 millivolts higher than the initial value.

The variation of ε_H with time (up to 1 hr.) was determined at 100° C. (212° F.) for 18-8 stainless plus columbium in 60% HNO_3, and in HNO_3 with additions of oxidizing agents. In the 60% HNO_3 solution, the initial ε_H was 1160 millivolts and, after 1 hr. 1180 millivolts; with the addition of 5% $K_2Cr_2O_7$ the initial value was 1170 and the final value was 1370. Additions of 2.5% NH_4VO_3 and 5% KIO_3 gave initial values of 1160 and 1100, and final values of 1240 and 1200, respectively. Similar influence of additions of oxidizing agents to nitric acid

(*Continued on p. 126*)

*Digest of "Corrosion Properties of Stainless Steels in Oxidizing Solutions", by M. M. Kurtepov and G. V. Akimov, *Doklady Akademii Nauk SSSR*, Vol. 87, 1952, p. 1005.



▲Looking toward the charging end of this 52-ft long furnace designed by R-S Products Corporation. The CARBOFRAX skids are staggered to provide for expansion. Toothlike conveyor chains move the pipe through the furnace.

Outside view of the same furnace. ▶

No repairs in 3 years...

but there's even more to this skid rail story

This furnace is used to anneal large cast-iron pipe. It was put in operation by Glamorgan Pipe & Foundry Company of Lynchburg, Va. in the Spring of 1947.

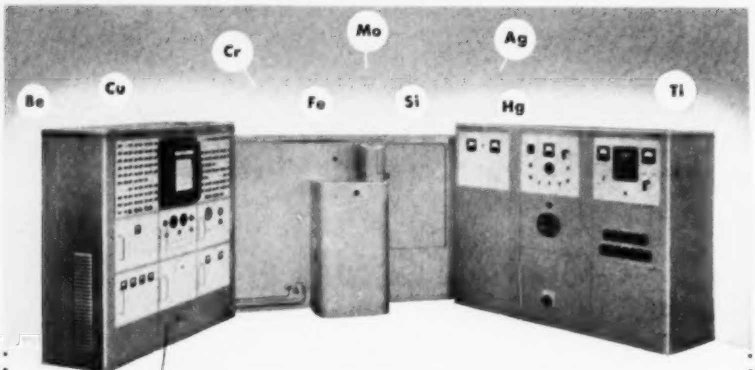
Week after week the CARBOFRAX® silicon carbide skid rails did their job without any attention whatsoever — *for three full years*. Then, less than half the rails were replaced. Another partial replacement followed two years later. And today, some of the original rails are still in use after six years. But this is just half the story!

These refractory skids also prevented the usual troubles experienced when water cooling is used. That is, the non-cooled CARBOFRAX rails gave a hot, point-of-contact surface so that the pipes heated evenly and were free from cold spots. Moreover, CARBOFRAX skids cost much less than alloy pipe.

CARBOFRAX skid rails can provide similar benefits in most reheating furnaces. If you have not investigated, it may pay to do so. Start by getting our complimentary skid rail booklet. Address: Dept. C-73, Refractories Div., The Carborundum Company, Perth Amboy, N. J.

CARBORUNDUM

Registered Trade Mark



Element Determinations are

2300% FASTER

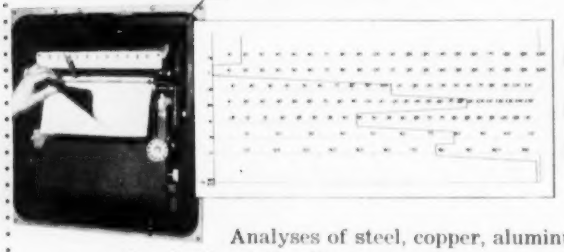
WITH

ARL PRODUCTION CONTROL QUANTOMETERS*

Users** of ARL equipment have found by actual experience that 42.50 element determinations per man-hour can be made by Quantometric analysis as against 1.85 determinations by chemical means. This means a tremendous savings in labor and time in routine production control analysis of almost any metallic alloy or inorganic compound.

Quantometers are photoelectric instruments that measure the quantities of most of the elements present in a sample. Each PCQ can measure and record quantitatively any 35 elements of your choice—as many as 20 simultaneously. Because this PCQ is completely direct reading, you get a multiple copy, inked record of the analysis of these elements in less than two minutes!

In addition to speed you get



COMPLETE ANALYTICAL COVERAGE

Analyses of steel, copper, aluminum, magnesium, zinc, lead and tin alloys are common accomplishments. Nonmetallics, such as ores, slags, cement, lubricating oils, etc., may be analyzed with the PCQ. A single PCQ permits analyses of elements in several types of base materials thus serving as a multiple purpose unit when required.

Truly, the ARL Production Control Quantometer CAN SAVE YOU MONEY in so many ways in your manufacturing processes that it deserves your most earnest consideration.

*Trade Mark

**Names furnished on request

The ARL line also includes 1.5 and 2-meter Spectrographs, Precision Source Units, Raman Spectrographs and related accessories.

Applied Research Laboratories

SPECTROCHEMICAL EQUIPMENT

3717 PARK PLACE GLENDALE 8, CALIFORNIA

NEW YORK • PITTSBURGH • DETROIT • CHICAGO • DALLAS • LOS ANGELES • LAUSANNE, Switzerland

Corrosion of 18-8 in Oxidizing Solutions

(Continued from p. 124)

solutions on electrode potential was observed for other stainless steels.

Data were obtained on the influence of an addition of 5% $K_2Cr_2O_7$ to a 60% HNO_3 solution on the kinetics of electrode processes for a plain 18-8 stainless (Russian Type EYa1T) by determining the curves of cathodic and anodic polarization at 20 and 100° C. (68 and 212° F.). Since higher polarizations were developed in the absence of the $K_2Cr_2O_7$ addition, it was concluded that such additions accelerate the cathodic and anodic processes. An increase in temperature facilitates both processes. A. G. Guy

Process for Aluminum Plating From Nonaqueous Solution*

Dense, ductile electrodeposits of aluminum are being obtained at room temperature from an organic plating bath consisting of an ether solution of aluminum chloride and lithium hydride or lithium-aluminum hydride. Although electrodeposition from nonaqueous solutions has been tried in the past, the procedures were not suited for practical applications because the deposits lacked purity, ductility, and other desirable qualities. The new bath is expected to find important application for electroforming articles that require close inside tolerances, such as waveguides, and for providing various types of equipment with a thin protective coating of aluminum.

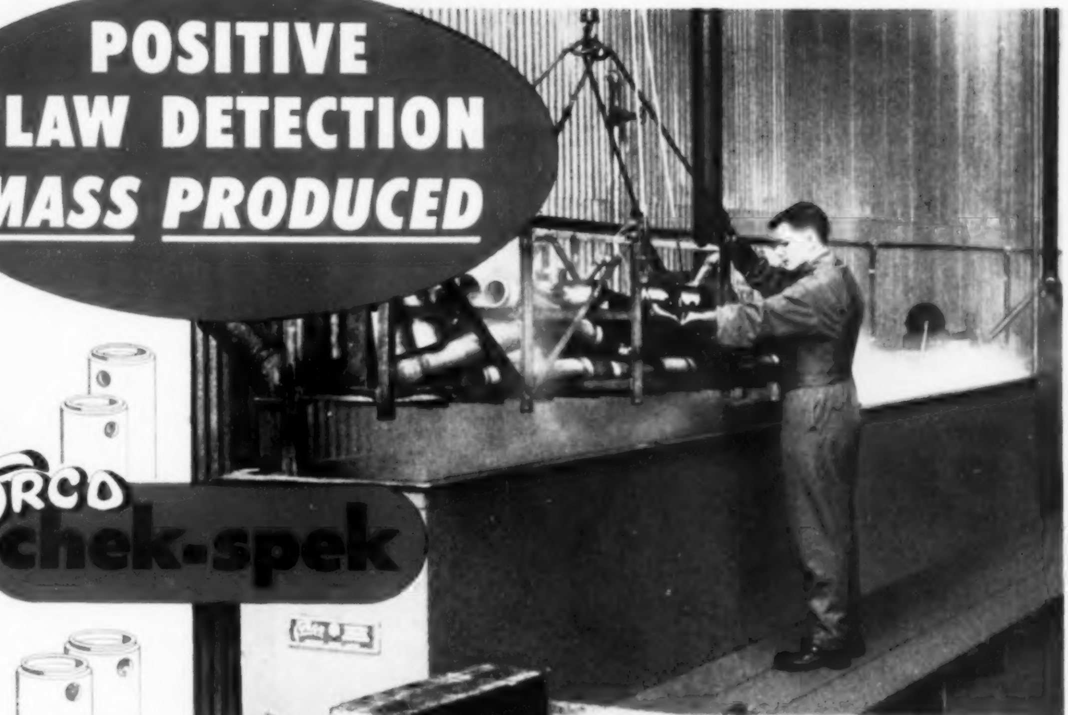
The aluminum plating bath is prepared at the National Bureau of Standards by the addition of either lithium hydride or lithium-aluminum hydride to an anhydrous and alcohol-free ethyl ether solution of anhydrous aluminum chloride. Concentration of aluminum chloride may vary from 1 to 4 molar, and current densities may be as high as 4 or 5 amp. per sq.dm. (decimeter). For

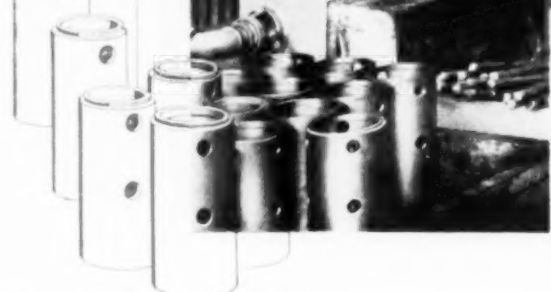
(Continued on p. 128)

*Digest of "A Hydride Bath for the Electrodeposition of Aluminum", by Dwight E. Couch and Abner Brenner, *Journal* of the Electrochemical Society, Vol. 99, June 1952, p. 234.

POSITIVE FLAW DETECTION *MASS PRODUCED*

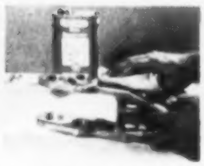
with Turco chek-spek





For Portable Checking

FOUR SIMPLE STEPS...



STEP 1: Clean surface

STEP 2: Apply Dy Chek Dye Penetrant

STEP 3: Remove Excess Dye Penetrant with Dy-Chek Dye Remover

STEP 4: Apply Dy Chek Developer. Flaws are revealed

ACCURATE ... SIMPLE ... FAST ... ECONOMICAL

... and now ... *for small parts* ... through Turco Chek-Spek ... you get positive flaw detection ... *on a production line schedule.*

Basically, Turco Chek-Spek employs the dye-penetrant method made famous on large units by Turco Dy-Chek. Here, for the first time Turco brings you a medium, Chek-Spek, which will accurately inspect thousands of parts per hour. If you are interested in cutting costs and improving quality, get the Turco Chek-Spek *mass production* story today.

For Cleaning or Metal Conditioning Problems... Turn to Turco First!

Hot or Cold Immersion — Spray Washing — Steam Cleaning

Solvent Spray — Phosphate Coating — Paint Removing

67 SPECIALIZED SERVICE CENTERS

From coast-to-coast and border-to-border Turco specialists and Turco warehouses are in most principal cities. Consult your local classified phone book for the one nearest you.

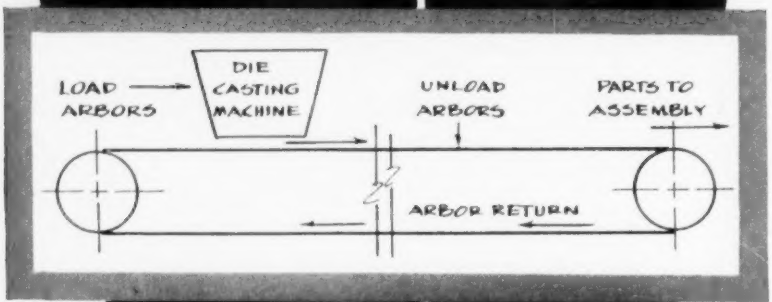
TURCO PRODUCTS, INC.

Chemical Processing Compounds

6135 South Central Ave., Los Angeles 1

Factories:
Newark, Chicago, Houston, Los Angeles

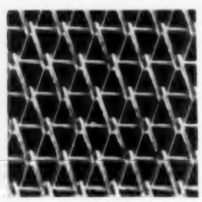
This **CAMBRIDGE WIRE MESH BELT** **LEADS A DOUBLE LIFE**



Here's a customer who gets double use from his Cambridge wire mesh conveyor belt. He uses the top side of the belt to carry loaded arbors from the diecasting machine . . . *uses the bottom side to carry empty arbors back to the machine for re-use.* Savings in equipment! Savings in floor space! Savings in handling and time!

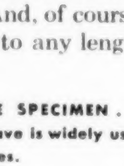
Room air circulates freely through the open mesh of the belt to cool the castings. Hot castings cannot harm the all-metal belt. The moving belt feeds parts to the subsequent assembly line at a constant rate of speed.

Even if you're not making diecastings, Cambridge wire mesh conveyor belts can help do many jobs in your plant . . . heat treating, brazing, sintering, pickling, quenching, to name just a few. They can be woven from any metal or alloy, thus can be used under even the most corrosive conditions. They can be fabricated in a wide variety of open or closed meshes, thus can be used for handling small or large parts. And, of course, Cambridge belts are made to any length or width.



HERE'S A TYPICAL CAMBRIDGE SPECIMEN . . . Rod-Reinforced. This particular weave is widely used in continuous heat treating furnaces.

For complete information on how Cambridge wire mesh belts can help you combine movement with processing, call in your Cambridge Field Engineer. He's listed under "Belting-Mechanical" in your classified telephone book. Or, write direct for this NEW, WIRE MESH BELT CATALOG. IT'S FREE! Gives conveyor and conveyor belt design and installation data, metallurgical tables, other useful information.



The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department B
Cambridge 7,
Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

Aluminum Plating From Nonaqueous Solution

(Continued from p. 126)

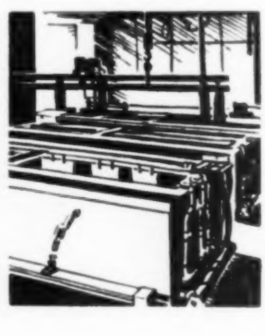
thicker deposits, the current density should not exceed 2 amp. per sq.dm.

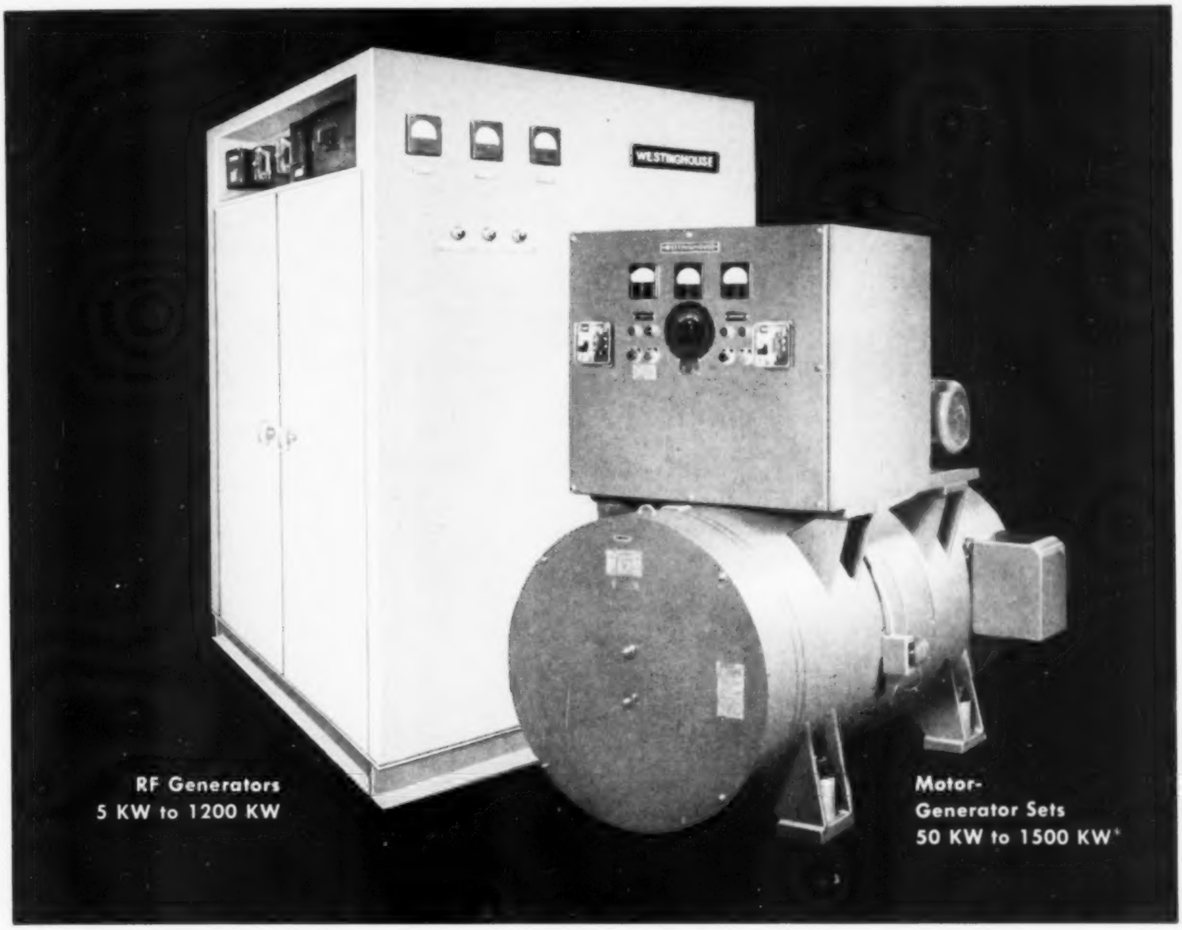
The bath is prepared and used in a closed container to prevent the entrance of moisture; it is a glass plating vessel with a tightly fitted polyethylene lid. Anodes of aluminum rod pass through the lid. The objects to be plated (cathode) are introduced and removed through a central hole in the lid, being kept closed during the plating operation. Agitation is undesirable, as a quiescent bath allows the sediment from the anodes to settle to the bottom of the vessel, making bagging of the anodes and filtration of the solution unnecessary. Bath composition is easily controlled with occasional additions of lithium hydride. The bath slowly deteriorates as the lithium hydride becomes insoluble and this condition results in streaked and brittle deposits.

A bath having a normal content of lithium hydride produces deposits that are white, matte and quite ductile, and the plate is virtually free of pits; a lithium hydride content less than 3 or 4 g. per l. results in deposits that are hard, brittle, and gray. A hydride content below this level causes the deposits to crack or peel.

It is reported that cathode and anode efficiencies for this process are close to 100%. Thickness of deposits is 0.05 in., although this may be exceeded if the sharp edges of the cathode are shielded to prevent treeing. Deposits obtained at lower current densities have large columnar crystals; periodic reverse current gives some refinement of grain, but not nearly as much as obtained with the addition of a small amount of β, β'-dichloroethyl ether to the bath.

J. Parina, Jr.





FOR INDUCTION HEATING—SPECIFY WESTINGHOUSE

Leader for Years in Total KW in Use—Years of experience gained by Westinghouse from hundreds of induction heating installations throughout industry can be applied now to your own heat-treating needs. You are assured of reliability — proved by the fact that the total kilowatt-hours generated by installed Westinghouse induction heating equipment has exceeded, year in year out, that of any other manufacturer.

And you know that Westinghouse, as a manufacturer of both motor-generator and radio-frequency-generator induction heating units, is in a position to recommend equipment without bias for your specific requirements. Whatever your heat-treating problem, inquire about these efficient, versatile tools now. Call your Westinghouse representative or write: Westinghouse Electric Corporation, Electronics Division, Induction Heating Section, 2519 Wilkens Avenue, Baltimore 3, Maryland.

**Higher ratings can be supplied for any specific purpose.*

YOU CAN BE SURE...IF IT'S

Westinghouse

LOW COST
IRIDITE®
FINISHES

for zinc, cadmium, aluminum and cuprous metals

provide corrosion resistance
paint base
choice of appearance

And they are easy to apply! Just a simple chemical dip for only a few seconds produces the coating.

LOW MATERIAL AND SHIPPING COSTS

combine to make Iridite the most economical chromate finish you can buy. Many Iridite chemicals are packed in powder form, thus can be shipped to you in steel pails at freight savings of up to 75%! Pails take less storage space, are easier to handle, eliminate carboys, need not be returned.

WHY NOT TEST IRIDITE ON YOUR PRODUCTS? Write for literature and send samples for free test processing. See "Plating Supplies" in your classified telephone directory or write direct.

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD.

Creep Resistance of Wrought Carbon Steels*

The results of the study of the creep properties of carbon steel over the period from 1929 to 1948 are summarized in this paper. This work was done at the National Physical Laboratory under the Committee on Steels for High-Temperature Service of the British Research Assoc. The report is mainly confined to a discussion of the creep properties of carbon steels at 450° C. (750° F.), the optimum temperature at which this type of steel is considered adequate. As low-carbon steels have long been used in America at temperatures as high as 1000° F., this temperature limit seems to be on the conservative side.

Many types of carbon steels were tested and, as information accumulated, the effects of factors, such as grain size, melting furnace, deoxidation, carbide distribution, normality (as measured by the McQuaid-Ehn test), were surveyed. Since all of these factors have long been under discussion in this country, the results should be of interest. Throughout the years a total of 70 heats of carbon steel was tested, the origins of which are listed below:

Uses	Heats
Tubes of Basic O. H.	11
Bars of Basic O. H.	14
Plates of Basic Electric	3
Steam Header Tube of Acid O. H.	1
Bars of Acid O. H.	2
Plates of Acid O. H.	6
Boiler Drums of Acid O. H.	23

Complete details as to melting practice, deoxidation, chemical composition, content of oxygen, nitrogen and hydrogen content, the heat treatment of specimens, and similar data are given in five tables. In addition, micrographs of the structures tested are included.

To expedite the work, all tests were carried out for a period of 2 to 8 days (usually 5 days) at a temperature of 450° C. (750° F.) under a constant load of 8 tons per sq.in. (17,920 psi.). This standardized procedure is based on the B.S.I.

(*Continued on p. 132*)

*Digest of "Factors Influencing the Creep Resistance of Wrought Carbon Steels", by C. H. M. Jenkins and H. J. Tapsell, *Journal* of the Iron & Steel Institute, Vol. 171, August 1952, p. 359-371.

OPERATOR REMOVES TRAY OF STEEL PARTS FROM ANNEALING FURNACE. G-E PYROMETER FURNISHES THE REQUIRED PRECISION CONTROL.

on small furnaces, ovens, kilns . . .

Use G-E Pyrometers for Precision Process Control

For single-unit process control jobs, such as the annealing operation shown above, cost takes on extra importance. General Electric's line of pyrometers offers relatively inexpensive control for common applications where reading accuracy within $\frac{3}{4}$ of 1% is permissible.

Low-cost control begins with G.E.'s low pyrometer prices. Prices start at $215.78*.

PRECISION CONTROL is your assurance that G-E pyrometers will read the same every time temperature conditions are the same. That's repeatability—the essence of precision control. A repeatable process means identical results, so important to modern industrial production.

HIGH SENSITIVITY—any change in temperature equivalent to 1/10 of 1% of full scale is enough to initiate control action. Tight sealing of all removable parts helps keep dirt or moisture from disturbing this sensitive control.

ACCURACY is sustained with automatic cold-junction compensation. This feature prevents any changes in ambient temperature (within 20 to 140°) from distorting the true reading.

Accuracy is held to within $\frac{3}{4}$ of 1% of full scale.

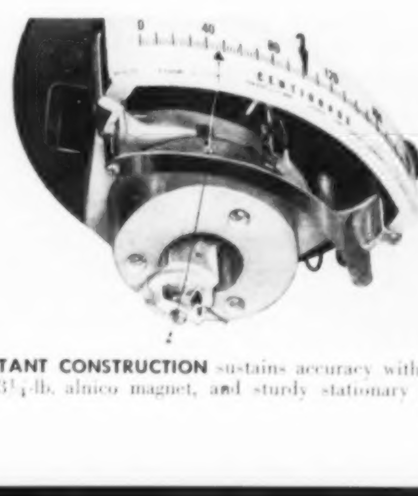
SEVERAL TYPES AVAILABLE, including indicators, indicator controllers, and protectors. Offered in either 2-position or 3-position models for flush or surface mounting. Scale requirements can be fulfilled from a variety of temperature ranges in the 0-3000F span.

FOR COMPLETE INFORMATION, contact your G-E Apparatus Sales representative, or write for Bulletin GEC-713 to General Electric, Section 602-255, Schenectady 5, N. Y.

*Mfr's Suggested Retail Price.

GENERAL ELECTRIC

EASY MAINTENANCE is evident in such G-E construction features as the plug-in indicator and control units—replaceable in a moment.



SHOCK-RESISTANT CONSTRUCTION sustains accuracy with light moving-unit, $3\frac{1}{4}$-lb. alnico magnet, and sturdy stationary parts.

WILSON "ROCKWELL"*... the Jewel of Hardness Testers

• Always the leader . . . recognized and respected. Its quality has been imitated, but never attained. The WILSON "ROCKWELL" sets itself apart—stands alone—as the jewel of Hardness Testers. WILSON accepts the responsibility of leadership.

The many models of WILSON "ROCKWELL" for normal and superficial hardness testing offer the utmost in production as well as laboratory work. The various models of WILSON TUKON micro and macro hardness testers cover the entire range of scientific uses. Standards set by WILSON "ROCKWELL" and TUKON testers are accepted everywhere.

Be sure. Look to WILSON for the hardness testers you need. Don't be satisfied with anything less than a genuine "ROCKWELL." It may cost less than you think.

Write today for literature and prices.

*Trade Mark Registered

ACCO

WILSON MECHANICAL INSTRUMENT DIVISION
AMERICAN CHAIN & CABLE

230-F Park Avenue, New York 17, N. Y.

WILSON "ROCKWELL" and TUKON Hardness Testers

Creep Resistance of Wrought Carbon Steels

(Continued from p. 130)

standard for boiler plates, and in this report a creep rate exceeding 50×10^{-6} in. per in. per hr. between one and two days defines a steel of poor creep resistance designated as "abnormal". Although it is now thought in this country that such short testing periods are quite unreliable, the results give a means of classifying the different carbon steels and agree very generally with American opinion on this subject.

The influence of chemical composition of the steels on the creep rate may be summarized as follows:

1. Carbon between 0.10 and 0.42% had no significant effect.
2. Manganese above 0.65% caused a decrease in creep rate, and a retarding effect on the rate of spheroidization of pearlite.
3. Low silicon (under 0.10%) steels had very high creep rate. All of the "good" steels had a silicon content above 0.20%.
4. High aluminum content, indicating excessive use of aluminum in deoxidation (over 1 lb. per ton), was found to cause the highest creep rate and the greatest tendency to spheroidal structure.
5. Steels with the lowest creep rates contained over 0.010% oxygen, while the steels with less than 0.008% oxygen showed higher creep rates. The tables for these analyses show little correlation between the aluminum and oxygen content.

The influence of heat treatments on the steel was found to agree closely with American results. Coarse-grained specimens yielded the lowest creep rate for any given steel, and those of fine grain size the highest creep rate of all. The creep varied from 1×10^{-6} in. per in. per hr. for the best steel to 260×10^{-6} in. for the poorest steel when all samples were normalized at 900° C. (1650° F.). Of the 70 tests tested, 42 heats showed creep rates of less than 2.5×10^{-6} in. per in. per hr.; 28 heats from $2.5 \times 10 \times 10^{-6}$ in. per in. per hr.; and 15 heats over 100×10^{-6} in. per in. per hr. All of the best steels were made in the acid openhearth furnace. None of these were treated with more than 0.5 lb. Al per ton and all contained over 0.25% silicon. *(Continued on p. 134)*

Are You Using Special Alloy Steels for Standard Alloy Jobs?

An estimated 95 of every 100 civilian and military jobs that require alloy steel can be handled effectively with AISI standard alloy grades. Generally speaking, the exceptions that call for special alloy grades are those jobs involving resistance to heat, corrosion, or low-temperature impact.

You Benefit by Using Standard AISI Grades

The vast majority of engineering applications for alloy steel simply involve heat treating to required levels of strength or hardness. For these applications standard alloy steels will quench out to practically any combination of properties. And the over-alloying of a small section will add nothing to its properties, and will make it more susceptible to quenching cracks.

The chemical ranges of standard grades usually fall within closer limits than those of special steels. Standard methods of heat treatment can be employed and the resulting property ranges can be predicted to a closer degree.

You can ordinarily get better deliveries of standard grades. This means that you can operate with smaller inventories and with less capital tied up in slower-moving special grades.

At Bethlehem we manufacture special-analysis alloy steels as well as the entire range of AISI standard alloy grades and standard carbon steels. We are obviously in a position to make unbiased recommendations. Our metallurgists are experienced in solving problems that pertain to all types of steel. Call on us for advice at any time.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

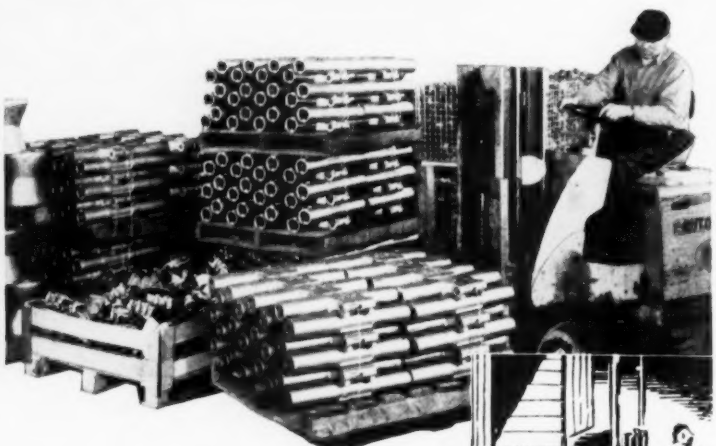
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM ALLOY STEELS

NO. 2 IN A SERIES

UNITCASTINGS are consistently better!

"Palletizing" SAVES YOU HANDLING TIME!



For greater efficiency, your steel castings are handled *on pallets* in the Unitcast foundry . . . and, if you desire, can be *shipped* to you on pallets to save handling time and expense at your end.

Your fork-lift trucks can move "Palletized" casting shipments directly to your assembly floor or machining operation *in quantity and without additional and unnecessary handling!*

Cut your handling costs . . . *specify Palletizing!* Another time-saving service available from Unitcast.

UNITCAST *Corporation* QUALITY STEEL CASTINGS

Our steel casting specialists welcome the opportunity of working with you on your parts problems... their suggestions at the design stage can pay you continuous dividends.

Write or call . . . Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio; 701 New Center Bldg., Detroit, Michigan. In Canada: Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS are FOUNDRY ENGINEERED

Creep Resistance of Wrought Carbon Steels

(*Continued from p. 132*)

All steels which exhibited a creep rate under 11×10^{-6} in. per in. per hr. developed a normal coarse-grained pearlite structure in the McQuaid-Ehn test, while those with a creep exceeding 140×10^{-6} in. per in. per hr. were distinctly abnormal. Micrographs depicting these tests are given in the paper.

E. C. Wright

Creep Resisting Ferritic Steels*

Stresses and temperatures at the hot end of most gas turbines, designed with one-piece rotors, generally exclude the use of steels whose creep properties are no better than those identified with low-alloy steels of the carbon-molybdenum type. However, where a built-up rotor is a feature of the design, such steels may be used for one or more of the low-temperature stages. In the multi-piece rotor there is at least one stage where a steel is needed with properties somewhat superior to those obtainable with carbon-molybdenum. Several ferritic and austenitic steels are adaptable.

The trend today is toward the use of ferritic steel forgings, since they offer a number of advantages – less costly in respect to alloying elements, easier manufacture and lower expansion properties which mean lower thermal stresses in practice. But ferritic steels have creep properties inferior to austenitic, so it is necessary to limit the maximum metal temperature to suit the steels available, this usually being done by admitting cooling air to the rotor.

Thus the level of creep resistance must be as high as possible for at least the forging used in the first stage and this usually means that something at least as good as molybdenum-vanadium steel is required. The number of ferritic steels which fulfill the requirements is not large. They include molybdenum-vana-

(*Continued on p. 136*)

*Digest of "Creep Resisting Ferritic Steels for Gas Turbines", by H. W. Kirby, *Alloy Metals Review*, published by High Speed Steel Alloys Ltd., Widnes, Lancashire, England, Vol. 8, December 1952, p. 2-6.

Desand-degraphitize castings in 10 minutes with VIRGO® MOLTEN CLEANER

UNLOADING VIRGO-CLEANED CASTINGS from continuous cleaning line.

HERE ARE THE BENEFITS!

- **Longer machine tool life.**
- **All surface defects show up.**
- **A cleaner, better product.**

With Virgo Molten Cleaner your castings are completely free from sand and graphite before they are machined, giving you greater machine tool life. Any surface defects on castings are shown up, and you can scrap defective castings before they are machined. This same freedom from impurities insures trouble-free operation for your product when it is placed in use.

The process is simple and easy to operate—does not require close supervision. A five-minute immersion of castings in Virgo Molten Cleaner bath at 800° F. is usually enough to dissolve every trace of sand, and dissolve graphite to satisfactory depth. A water quench removes salt and leaves a protective coating on the castings. (This coating is corrosion-resistant and may be left on if castings are to be stored.) The coating is removed by a three-minute dip in dilute acid. A brief water hosing or rinse completes the job.

You can use the Virgo bath, at higher temperature, to stress relieve while desanding. By combining operations in this way, costly annealing equipment, as well as the additional operation can be eliminated.

For full details and description of this process, write us today. Please use your business letterhead or coupon below.

For Fast, Safe, Low-Cost DESCALING—VIRGO® DESCALING SALT

Producers and fabricators of stainless and alloy steels use Virgo Descaling Salt to quickly remove scale produced by hot rolling, forging, extruding, casting, annealing. The Hooker Process is backed by 15 years' experience in salt bath descaling and cleaning. Engineering, research and on-site operating assistance are part of our service.

SEND FOR THESE BULLETINS

They tell the whole story on Virgo Descaling Salt and Virgo Molten Cleaner—what they are, how they work, their advantages, equipment involved, and the Hooker services you enjoy as a user of the process.

HOOKER CHEMICALS ®

1-1949

From the Salt of the Earth

HOOKER ELECTROCHEMICAL COMPANY

30 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y.
NEW YORK, N. Y.
LOS ANGELES, CALIF.
TACOMA, WASH.
CHICAGO, ILL.

Hooker Electrochemical Company
30 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y.

Please send me Bulletins checked: Virgo Descaling Salt ☐
Virgo Molten Cleaner ☐

NAME ____________________

TITLE ____________________

COMPANY ____________________

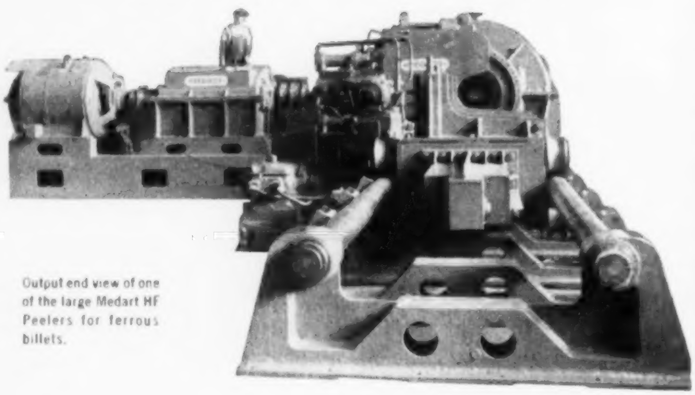
ADDRESS ____________________

CITY ____________ ZONE ______ STATE ______

Billets Peeled at 20', 30', even 40' Per Minute!

MEDART

MODEL HF
BILLET PEELERS



Output end view of one of the large Medart HF Peelers for ferrous billets.

The output of Medart Billet Peelers is limited only by the capacity of the best available cutting tools! That means the absolute maximum in production at the lowest possible cost!

Built to handle both ferrous billets from 1" to 14" diameter — as well as brass, copper, aluminum and other non-ferrous metals — the throughput speeds of these Medart Peelers range from 1' to 40' per minute, depending upon workpiece size and material. They can be equipped with either one or two cutterheads — arranged for high surface finish or heaviest hogging cuts — and furnished with hydraulic or pneumatic controls, with push-pull feed devices, and for completely automatic operation.

No other scalping or turning machines made can match the production speed or economy of Medart's complete line of Billet Peelers.

Write NOW For Catalog!

THE MEDART COMPANY 3535 DE KALB STREET ST. LOUIS 18, MISSOURI

Creep Resisting Ferritic Steels

(Continued from p. 134)

dium types (0.1 to 0.2% C, 0.5 to 0.8% Mo, 0.2 to 0.3% V) which vary in creep properties according to carbon content and heat treatment. In general, forgings have creep properties superior to bar stock of similar composition and with nominally the same heat treatment. Stresses in gas turbine rotors or discs vary but, assuming a stress of 12,000 to 14,000 psi., then the maximum creep deformation would be 0.2% for 20,000-hr. life at 1020° F. For a 100,000-hr. period, optimum temperature would be about 970 to 985° F.

A 3% chromium-molybdenum-tungsten-vanadium (0.15 to 0.25% C, 2.5 to 3% Cr, 0.4 to 0.6% Mo, 0.4 to 0.6% W and 0.6 to 1.0% V) has creep properties similar to molybdenum-vanadium steel on the basis of limited creep deformation; that is, 0.1 to 0.2%. At higher deformations, particularly when compared on the basis of stress to rupture, this analysis is superior to molybdenum-vanadium, but sufficient data are lacking to confirm this superiority at times of 20,000 hr. or more.

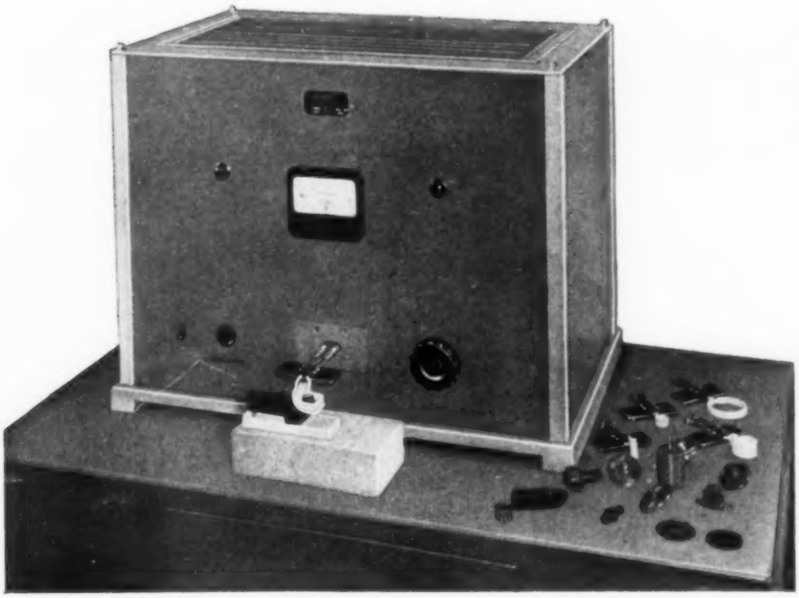
Research work on improved ferritic steels at Brown-Firth has been focused in terms of several "creep targets", each of which is related to certain gas turbine requirements. One is concerned with a material capable of giving a life of at least 20,000 hr. at 1100° F. or over, with a stress level of 12,000 psi. or over. Several analyses in the 10 to 12% Cr class seem promising.

Although possessing creep properties no better than carbon steel, blading of ordinary stainless ferritic steel has been used extensively in steam turbines. Operating temperatures of gas turbines, however, are such as to make ordinary stainless steel unsuited, except possibly in the final stage. Blade temperatures are higher than those at the rim of the rotor, but stresses are lower.

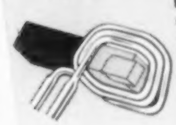
The author states that for temperatures of 1200° F. or over, and at stresses of 12,000 to 14,000 psi., the development of a ferritic forging steel to meet the requirements is likely to prove difficult. Not the least of the problems is the general inferiority of the ferritic matrix compared with its austenitic counterpart.

Lepel *presents*

A *Low Cost* PORTABLE HIGH FREQUENCY *Induction* HEATING UNIT

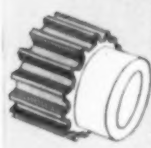


BRAZING



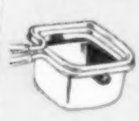
Permits widest choice of silver or copper brazing alloys from lowest to highest melting points. Ideal for brazing carbide tips.

HARDENING



Heat localized exactly where wanted at desired temperature. Ideal for gears, cams, bearing surfaces, cutting tools and other areas that are subject to wear.

SOLDERING

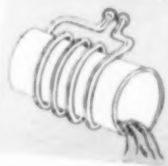


Speedily and neatly performs intricate soldering applications with or without the use of pre-formed rings.

ANNEALING

Ideal for annealing, stress-relieving, normalizing or pre-heating selected areas.

MELTING



Readily melts quantities of ferrous and non-ferrous metals in either graphite or ceramic crucibles.

- **SMALL AND COMPACT**
  Conveniently operated on bench or table—no mounting necessary.
- **ECONOMICAL OPERATION**
  No special power installation required. Operates on 110 volts, 60 or 50 cycle line at unity power factor.
- **FULLY GUARANTEED**
  Guaranteed for continuous duty cycle and stated performance.

This versatile unit is priced so low that every shop may now take advantage of modern induction heating techniques to improve quality and to increase production. Its simplicity of operation eliminates the need for skilled personnel.

The Lepel Model 2 KW will meet the requirements of machine shops, toolrooms, research laboratories and educational institutions. It is especially suitable for hardening, brazing and soldering small parts of either ferrous or non-ferrous metals.

Complete unit with line connection and load coil.

$870.
f.o.b. factory

WILL HEAT TO 1500° F.

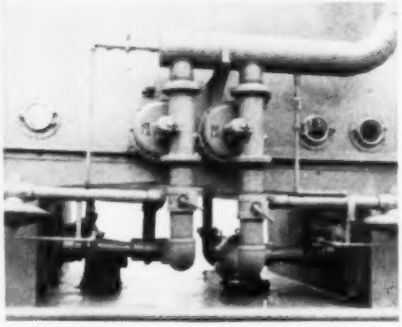
⅛"	steel	rod	1"	length	in	approx.	1	second
¼"	"	"	"	"	"	"	3	seconds
½"	"	"	"	"	"	"	15	seconds
1"	"	"	"	"	"	"	60	seconds

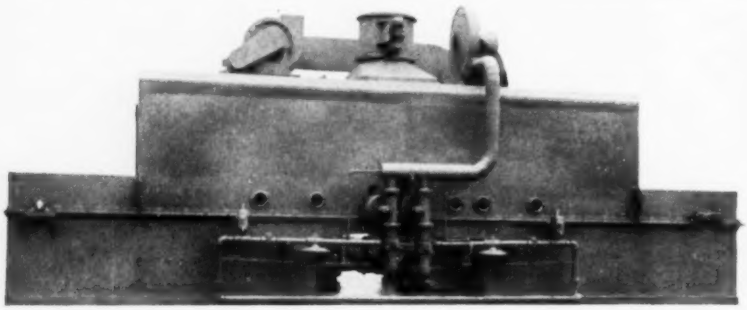
Will melt 4 ounces of brass or steel in 4 minutes.
Equally well suited for heating of non-ferrous metals.

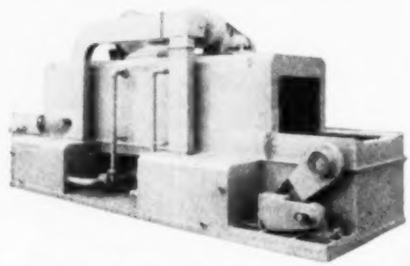
LEPEL HIGH FREQUENCY LABORATORIES, INC.
55th STREET and 37th AVENUE, WOODSIDE 77, NEW YORK CITY, N. Y.

All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission. *Write for Lepel Catalog MP-12.*

Machined Parts Need Their "Backs" Washed







The Gas-Fired Cabinet Type Power Spray Washer shown above is efficiently designed for cleaning parts after machining—a most important, between-operations step in obtaining the quality results so necessary for modern metal finishing. Peters-Dalton engineers were called upon to design and construct this highly efficient power spray washer—a real "backwasher"—with a "shower bath" that literally blasts the machined metal clean with jets of water under high pressure.

How about your industrial washing problems? Metal cleaning equipment should be designed for a specific product and process. PD engineers, with their extensive background and varied experience in the field, are ready and able to discuss your problems for between-operation cleaning or paint preparation. If you would like to hear more—write, wire or phone.

Hydro-Whirl Paint Spray Booths · *Industrial Washing Equipment* · *Drying and Baking Ovens* · *Hydro-Whirl Dust Collecting Systems*

Peters-Dalton INC.
17932 Ryan Road • Detroit 12, Michigan

Flash Welding of Railway Rails*

RAILS OFTEN suffer local failures, which necessitates their withdrawal from service, even though the major portions of the rails are still fit for use. The defective parts are removed and the remaining lengths are then joined together by resistance flash welding. Shortly after the end of World War II, attention was again turned to this process. It was found that the establishments carrying out the flash welding method of repairing rails could be divided into three types: firms having very little trouble and relatively few rejects; firms with a consistently high toll of rejects; and firms which produced repairs that fluctuated severely from low to high numbers of rejects.

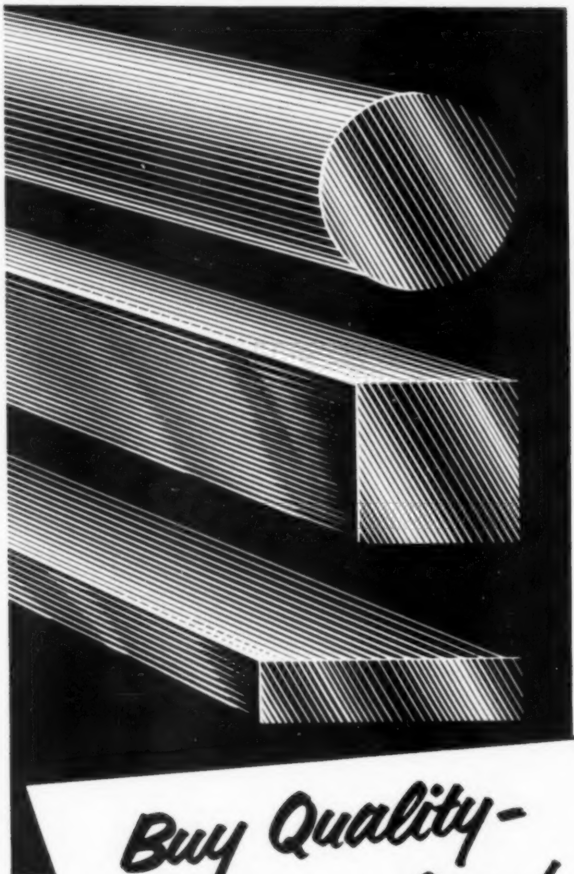
An investigation was made to determine which of the many possible major factors were responsible for these difficulties. As far as the material is concerned, rails of varying age and composition are delivered for repair. It was obvious that if an air hardening steel rail was welded to a rail of ordinary steel or to one with a hardened surface, the specified results could not be obtained. However, occasional failures are met, even with the welding of more common types of steel. This trouble is traced to excessive segregation which occurs more often in the low-silicon steels produced before 1930 than in the more recently produced higher silicon steels. Therefore, it is necessary to sort the rails before welding according to their similarity. Welding plants have found that rails with the same roll markings and year of rolling make the best combinations for welding.

Another consideration is the joining of rails having slightly different dimensions. For example, rails with excessive differences in height or breadth are often welded together. Another aspect of this problem is presented by the occasional shifting of the rails during welding, so that the ends are no longer in line. In

(Continued on p. 140)

*Digest of "Electrical Resistance Flash Welding of Railway Rails", by Reinhold Keuhnel, Report No. 308 of the Material Committee of Verein Deutsche Eisenhüttenleute, *Stahl und Eisen*, Vol. 72, Oct. 23, 1952, p. 1346-1348.

Made from Selected Heats



"Sure-Spec"

DRILL ROD

TOOL STEEL

ALLOY BARS

These quality Sure Spec cold finished bar steels provide—

1. Increased tensile strength
2. Increased yield strength
3. Increased tortional strength
4. Increased hardness
5. Resistance to wear
6. Decreased ductility
7. Excellent machinability
8. Smooth, bright finishes

Buy Quality-
Buy Sure-Spec!

Need a safe, sturdy steel storage cabinet for your bar stock? Write for details on our low priced locked cabinet or floor rack, each holds 20 different sizes.

"for service dependable as the sun"

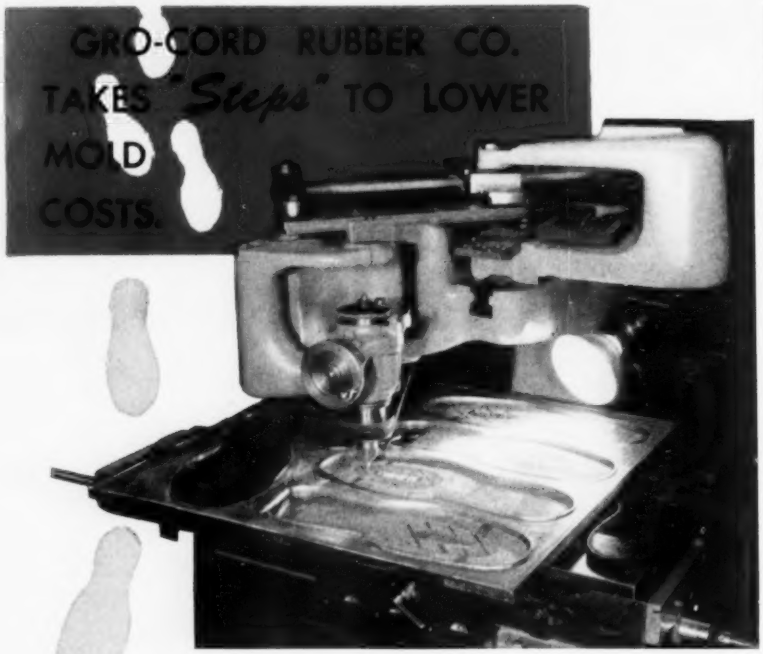
SOLAR STEEL CORPORATION

SURE — DEPENDABLE AS THE SUN — STEEL SERVICE — SPEC

General Offices: UNION COMMERCE BUILDING, CLEVELAND, OHIO

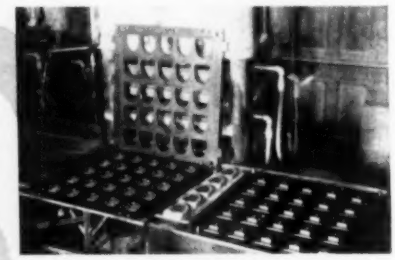
See your local classified telephone directory for our nearest office address

SALES OFFICES: Bridgeport • Chicago • Cincinnati • Cleveland • Detroit • Grand Rapids • Kalamazoo • Milwaukee • Nashville
Philadelphia • River Rouge, Mich. • Rochester, N. Y. • Toledo • Union, N. J. • Washington, D. C. • Worcester, Mass.



SPEED CASE STEEL PLATE EASIER TO MACHINE

The Gro-Cord Rubber Co., Lima, Ohio, produces "puddle-proof" Neo-Crepe, Neo-Cork and Neo-Cord heels and soles of molded neoprene. They are widely used by manufacturers of footwear. Gro-Cord has speeded production and cut tool room costs by making their molds of Speed Case (X1515) low carbon, open hearth steel plate. Ease of machining has increased tool life nearly 200% — machining speeds and feeds have been increased up to 50%. Speed Case takes a "beautiful" finish — can be engraved more readily. Physical properties are such that no heat treatment is necessary in this instance — although many users praise the rapid, deep case which can be produced through several methods of case hardening.



The Speed Steels — Speed Case, Speed Treat and Speed Alloy can probably cut your costs or improve your product — get the facts!

SPEED STEELS

SINCE 1856 W. J. HOLLIDAY & CO. INC.

SPEED ALLOY • SPEED CASE • SPEED TREAT

DISTRIBUTED BY

Brown-Wales Co., Cambridge-Hartford-Auburn. - Bridgeport Steel Co., Milford, Conn. Beals, McCarthy & Rogers, Buffalo, N. Y. - Burger Iron Co., Akron, Ohio - Grammer, Dempsey & Hudson, Inc., Newark, N. J. - Earle M. Jorgensen Co., Los Angeles-Houston-Oakland-Dallas - Passaic County Steel Service, Inc., Paterson, N. J. - Peckover's Ltd., Montreal-Toronto - Peninsular Steel Co., Detroit, Mich. - Pidgeon-Thomas Iron Co., Memphis, Tenn. - Horace T. Potts Co., Philadelphia-Baltimore-York, Pa.

Produced by W. J. Holliday & Co., Inc., Speed Steel Plate Division, Hammond, Indiana. Plants: Hammond and Indianapolis, Indiana

Flash Welding of Railway Rails

(Continued from p. 138)

these cases there are small areas in the extremities of the cross sections that are not properly welded and therefore will usually cause premature failures.

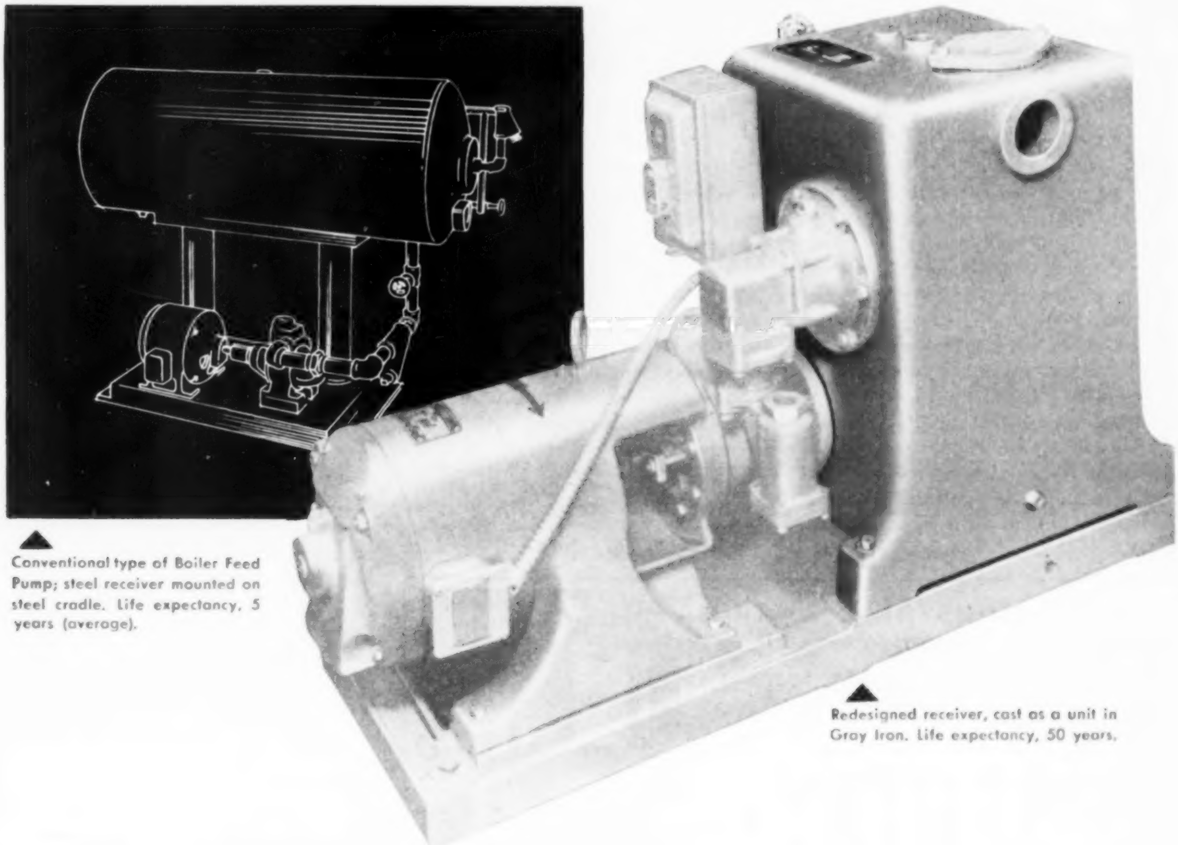
In the specifications for welded rails, published in 1950, it is stated that only rails of the same shape and tensile strength should be joined. Rails with a tensile strength of 120,000 psi. are considered to be wear resistant and must be handled separately and only by approved welding plants. Rails rolled before 1910 should be welded only under exceptional circumstances. The specifications also govern the permissible amount of rust, the manner of cutting the rails, and the minimum lengths of rail to be repaired.

The welding machines most successfully used are those produced by A. E. G. Siemens-Schuckert and H. Miebach between 1935 and 1950. Their capacities range from 160 to 320 kva. The specifications for post treatment and the microstructures obtained are also outlined.

Owing to the nature of resistance flash welding, it is impossible to observe the process closely. Another fundamental difficulty is presented by the shape of the rails. Rectangular, square or circular cross sections are much easier to weld properly than I-beams or rails. The heating is not uniform with the two latter shapes and therefore the extremities of the cross sections are often inadequately welded. This type of defect can be readily detected with magnetic powder tests, although this test has not come into common use in this field as yet.

Since direct observation of the welding process is impossible because of excessive spattering, the finished weldment must be inspected all the more carefully. The head, web and foot of the rail must be heated to the same distance on either side of the weld during the welding process. This is checked by the subsequent discoloration of the rail around the welded area. An eccentric position of the weld zone usually indicates defective heating during the welding process which can lead to premature failure.

(Continued on p. 142)



Conventional type of Boiler Feed Pump; steel receiver mounted on steel cradle. Life expectancy, 5 years (average).

Redesigned receiver, cast as a unit in Gray Iron. Life expectancy, 50 years.

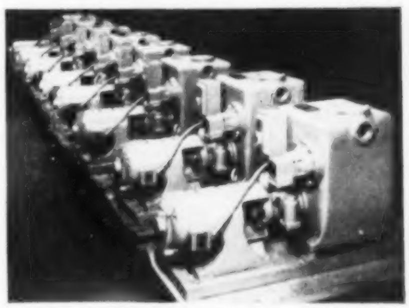
COST SAVINGS BUILT IN by practical use of GRAY IRON!

In Boiler Feed Pumps, first cost is less important than long-time economy. Because water conditions often cause certain materials to deteriorate rapidly, replacement costs are frequently high.

When a leading manufacturer replaced the conventional steel tank with a Gray Iron casting, here's what happened:

- In spite of somewhat higher initial cost, savings at the end of a 5-year period amounted to 38%—including replacement cost of steel tank, plus labor and fittings. This important saving in replacement cost will be realized every 5 years for approximately 50 years.
- By designing for the cast Gray Iron receiver and sub-base mounting, space requirements were reduced—excess piping, valves and fittings were eliminated.

Have you analyzed *your* product for possible cost savings which can be accomplished by designing for and with Gray Iron? Write for technical information on the many advantages of the Gray Iron casting process.



Boiler Feed Pumps with Gray Iron receivers, built for U. S. Navy.

**Make it Better with Gray Iron . . .
Second largest industry in the metal-working field**

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

Flash Welding of Railway Rails

(Continued from p. 140)

In addition to the visual examination of the weldments, welding quality of every series of welds is assessed by a bend test. Scrap pieces are used to produce the weld specimen of specified dimensions, and the bend test is made by the inspector. The weld specimen for this test is so marked that the inspector can identify the machine, the time and the operator. Since the application of this test specified by the German Railway Association, the original difficulties have been reduced and the number of premature failures has diminished to a more satisfactory level. R. C. SHINAY

Blowing Basic Pig Iron With Pure Oxygen*

THE AUTHORS give a thorough résumé of the progress made over the past 15 years by basic bessemer steel producers in Europe to improve the quality of steel made by this process. These investigations have been directed toward lowering the nitrogen content to less than 0.005% (approximating openhearth steel) in bottom-blown Thomas steel, the blowing of pig iron with varying phosphorus contents, and the development of deoxidizing practices which would produce fully killed steels of forging quality. Since 60% of all steel made in Europe is produced in the bottom-blown, basic-lined Thomas converter from pig irons with a limited phosphorus content (1.5 to 2.00%), the results of this work are of critical importance to the whole European steel industry.

Although it was observed by Bessemer 100 years ago that the use of oxygen instead of air for blowing would be desirable, and Geilenkirchen stated in 1904 that the use of oxygen would permit the bottom blowing of pig irons containing less than 1.50% phosphorus, these disclosures could not be put into practice due to the high cost of oxygen.

Finally in 1939, Eilander and Rosen reported the successful blowing of basic converters at the Maxhutte Works with oxygen-enriched air which produced steels having low nitrogen and phosphorus. Because of the higher temperatures developed with the higher oxygen blast, large additions of cold scrap were necessary. The steel which was produced was greatly superior to air-blown Thomas steel.

Following this early work, intensive investigations have been made of bottom-blowing Thomas converters using oxygen-enriched air, and of oxygen and steam blowing during the last 3 min.; in addition, studies of the use of oxygen and CO_2 mixtures during the later stages have been conducted in Germany, France, Belgium and Sweden. All of these operations have been accompanied by extra-large additions of cold scrap or iron ore to control the higher bath temperatures. Greater iron production is achieved from the extra iron obtained from these additions. In some operations as much as 44% of the total charge melted has been cold scrap. Large amounts of steel with very low nitrogen and phosphorus are now being produced in Belgium by the oxygen-steam blowing mixture in the last blowing stage. Steels with nitrogen as low as 0.002% have reportedly been made. One difficulty associated with bottom blowing that uses oxygen-enriched blast has been the greatly increased erosion of tuyeres and the decreased life of furnace bottoms.

In 1950, H. Hellbrugge reported on studies made of top blowing a 2-ton converter with pure oxygen

(Continued on p. 144)

*Digest of "Blowing Thomas Pig Iron With Pure Oxygen", by F. A. Springorum, Karl G. Speith and Willy Oelsen, *Stahl und Eisen*, Vol. 73, Jan. 1, 1953, p. 6-22.

JOIN INDUSTRIAL AMERICA—

Heat Treat High Speed Steel

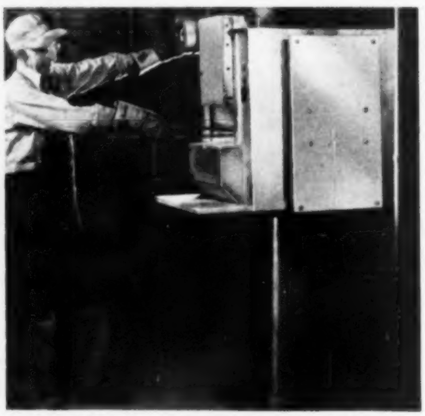
The SENTRY Way!

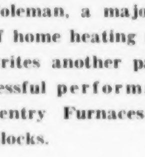
"ALWAYS ON DUTY"

"SENTRY—An Essential in our Tooling Operation," says Coleman

For more than 10 years the Sentry Model 4Y with Diamond Block has given Coleman dependable service. Mr. E. A. Bussard, Chief Process Engineer of the Coleman Company, Inc., Wichita, Kansas, says further: "The Sentry furnace is in almost daily operation for treating high speed steel."

Coleman, a major manufacturer of home heating equipment, thus writes another page in the successful performance history of Sentry Furnaces and Diamond Blocks.

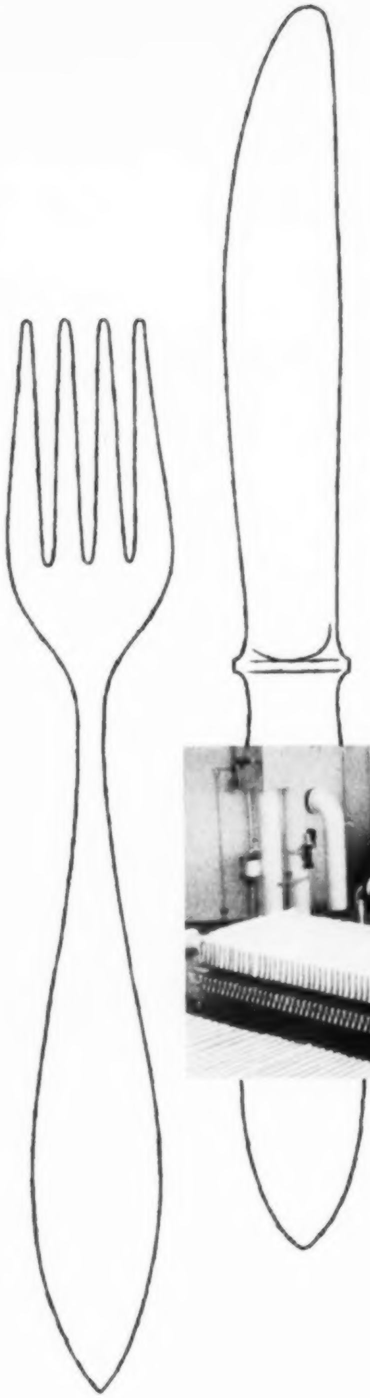

Sentry Model 4Y, size 4, as installed at The Coleman Company, Inc., Wichita, Kansas



Request Catalog C-3

THE SENTRY COMPANY

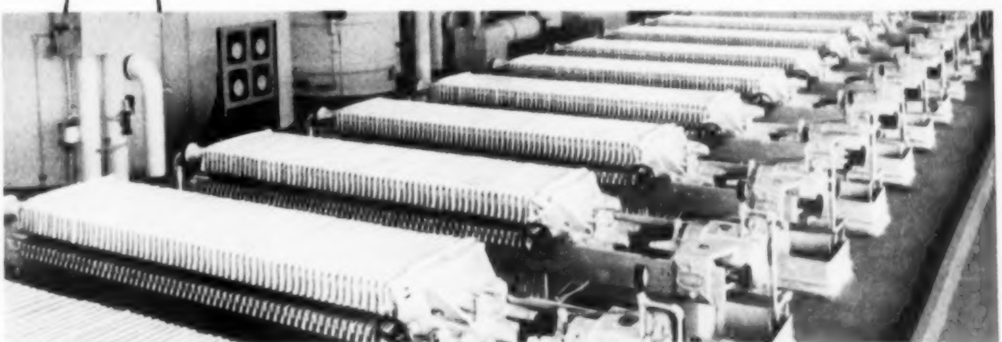
INDUSTRIAL ELECTRIC FURNACES AND EQUIPMENT FOR HEAT TREATMENT OF METALS



partners

in **filtering** foods and chemicals

We all owe a debt of gratitude to the manufacturers of food and chemical filtering equipment, for they have kept pace both in design and production with the expanding demand for high speed, complex filtration equipment. We at COOPER ALLOY, joining in this salute, take pride in our close association with the engineers and designers who have made these advances possible. From the producer of small laboratory filters, to the creator of huge production designs, the filter manufacturer knows that in COOPER ALLOY he has found a source for cast stainless steel components in whom he can place his trust. Our thirty



years of experience as the leading producer of corrosion resistant stainless castings, is your guarantee of a partnership that lasts. If you design or manufacture filters for the handling of corrosive liquids or foods, you should get to know us better. Send for your free copy of "Thirty Years of Progress" today!

COOPER ALLOY

THE COOPER ALLOY FOUNDRY CO. • HILLSIDE, N. J.

Los Angeles San Francisco Oakland Houston Chicago Detroit Philadelphia Hartford

Leading producers of STAINLESS STEEL valves, fittings and castings

☐ Please send your new booklet "Thirty Years of Progress"

☐ Please have your representative call.

Name ______ Position ______

Company ______

Address ______

City ______ Zone ______ State ______

OVER ONE HUNDRED YEARS OF CONTINUOUS SERVICE. ROUNDS, SQUARES, FLATS, HEXAGONS, OCTAGONS

HY-TEN

"B" No. 3X
HEAT-TREATED
BARS

This higher-priced alloy steel can save you money!

"B" No. 3X heat-treated bars offer many production economies, even though machined at about ¾ths the speed of annealed bars. They are supplied to your desired physical properties, and can be machined more easily than standard heat-treated bars with equivalent properties. The expense of scaling, distortion, straightening, and often grinding, are eliminated — as well as the cost of extra handling and heat treating of finished parts!

Although the cost is a little more than for ordinary annealed stock, a trial order will convince you of the true economy of HY-TEN "B" No. 3X heat-treated bars! Just call your nearest WL representative.

Write today for your FREE COPY of the Wheelock, Lovejoy Data Book, indicating your title and company identification. It contains complete technical information on grades, applications, physical properties, tests, heat treating, etc.

WHEELOCK, LOVEJOY & COMPANY, INC.

Warehouse Service

CAMBRIDGE • CLEVELAND
CHICAGO • HILLSIDE, N. J.
DETROIT • BUFFALO
CINCINNATI

In Canada
SANDERSON-NEWBOULD, LTD., MONTREAL

HY-TEN and AISI

134 Sidney St., Cambridge 39, Mass. and Cleveland • Chicago • Detroit
Hillside, N. J. • Buffalo • Cincinnati

BILLETS AND FORGINGS FOR PRODUCTION, TOOL ROOM AND MAINTENANCE REQUIREMENTS

Blowing Basic Pig Iron

(*Continued from p. 142*)

following the suggestion of R. Durrer in 1948. The blast was introduced on top of the bath through a water-cooled copper tuyere. Tests on a 2-ton converter and also on larger vessels showed that top blowing with oxygen-enriched blast did little damage to the refractory lining. Following this work, further pilot plant tests were made at the Austrian Iron & Steel Works in Linz and one other Austrian plant. As a result, a plant with top-blown converters was built at Linz to produce 150,000 tons of steel yearly. It is stated that the cost of top blowing with oxygen-enriched blast is about 1% greater than the air bottom-blown conventional converter, but about 2% cheaper than openhearth steel when pig irons with 2% phosphorus are being processed. The fact that top blowing yields a low nitrogen steel with properties as good as those of basic openhearth steel and that it can operate with pig iron of any phosphorus level makes this new process of great interest to European steel producers.

GERMAN INVESTIGATIONS

The authors used a 3-ton basic lined converter without bottom tuyeres. The inside diameter was 35 in., the bath depth being 24 in. The oxygen (98%) was blown through a copper-cooled tuyere having an orifice 0.4 in. diameter and located 4 in. above the bath level. The charges averaged 5300 lb. with 12 to 15% burned lime. Additions of cold scrap were made to some heats, and additions of Austrian iron ore (containing 58.4% Fe, 0.30% Mn and 0.09% P) to other heats.

The oxygen had to be blown with sufficient pressure to push aside the slag which forms on the bath; however, the efficiency of oxidation was very good, for there was only a small amount of CO_2 in the gases. In heats with cold scrap additions, 3300 cu.ft. of oxygen per ton of metal was consumed; the heats using iron ore additions required only 2350 cu.ft. of oxygen. The experimental blows were interrupted occasionally to take slag and bath samples, and to measure temperatures. Charts and tabu-

(*Continued on p. 176*)


METAL PROGRESS
BULLETIN BOARD
THE BUYERS' GUIDE FOR METALS ENGINEERS
CASTINGS
CLEANING & FINISHING
FORMING EQUIPMENT
HEAT TREATING SERVICES
HEAT TREATING SUPPLIES
INSTRUMENTS
LABORATORY EQUIPMENT
METALS & ALLOYS
TESTING
WELDING

DANIELS UTILITY BATCH PLATER

New multiple DANIELS PLATING BARREL unit designed to handle small lots of work economically. Individual removable tanks allow plater wide range of plating, pickling, or cleaning applications.

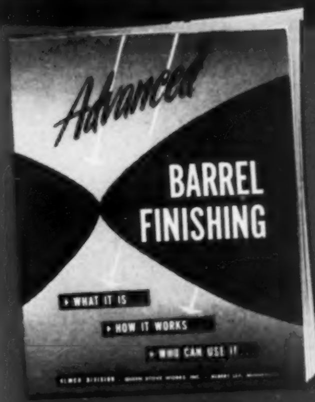
Send for complete details on this and other plating equipment.

DANIELS PLATING BARREL & SUPPLY CO.
MANUFACTURERS and DISTRIBUTORS
Electroplating and Polishing Equipment and Supplies
129 Oliver Street, Newark 5, N. J. • Tel. MArket 3-7450

DANIELS

LIST NO. 17 ON INFO-COUPON PAGE 157

FREE



IF YOU PRODUCE PARTS THAT REQUIRE FINISHING OF ANY KIND

This amazing 22-page booklet is *guaranteed* to open your eyes! Gives latest, up-to-the-minute facts — figures — photos on advanced barrel finishing. Shows how single unit installation replaces from 2 to 12 men—*savings up to 95%* on almost all types of parts from large castings to small intricate parts.

Investigate today! Send for your FREE copy of Booklet No. J-7 today.

ALMCO Supersheen
AMERICA'S LARGEST MANUFACTURER OF ADVANCED BARREL FINISHING EQUIPMENT – MATERIALS AND COMPOUNDS
ALBERT LEA, MINNESOTA

LIST NO. 75 ON INFO-COUPON PAGE 157

MANHATTAN

Abrasive Wheels — Cut-off Wheels
Finishing Wheels—Diamond Wheels

Custom-made for your specific material removal problems

Foundry Snagging—Billet Surfacing—Centerless Grinding

Cutting and Surfacing concrete, granite, and marble

"Moldiscs" for rotary sanders

Grinding and Finishing stainless steel welds

Bearing Race Grinding and Finishing

Finishing Tools and Cutlery

Cutting-off—Wet or Dry Bars, Tubing, Structurals, etc. Foundry Cutting—standard and reinforced wheels

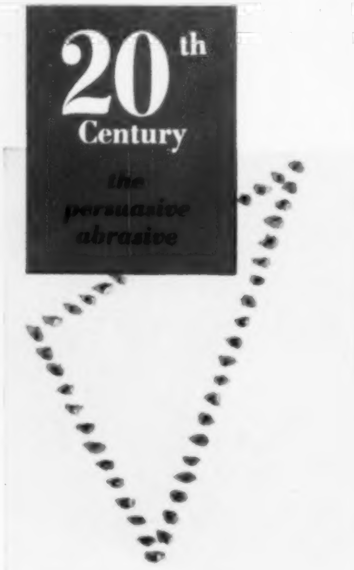
Grinding Carbide Tipped Tools

•

Write to Abrasive Wheel Department

Raybestos-Manhattan, Inc.
MANHATTAN RUBBER DIVISION
92 TOWNSEND ST. • PASSAIC N. J.

LIST NO. 1 ON INFO-COUPON PAGE 157



If you're working on the production cost angle in metal-working plants or foundries, consider the 20th Century triangle . . . abrasive toughness, economy, longer wear and highly uniform quality.

Our new catalog will give you more details.

THE CLEVELAND Metal Abrasive CO.

836 East 67th Street, Cleveland 8, Ohio
Howell Works: Howell, Michigan

*One of the world's largest producers of quality shot, grit and powder — Hard Iron — *Normalized — Cut Wire — Cast Steel*

*Copyrighted trade name

LIST NO. 2 ON INFO-COUPON PAGE 157

"Pur-Blac"

- Economical
- No Change in Dimension
- Corrosion Resistant
- Perfect Uniformity
- Non-Technical

The Black Oxide Finish That Penetrates Iron & Steel Surfaces

PURITAN MANUFACTURING CO.
WATERBURY, CONN.

LIST NO. 95 ON INFO-COUPON PAGE 157

BASKETS

for all industrial requirements

for de-greasing — pickling
anodizing — plating
materials handling
small-parts storage
of any size and shape —
any ductile metal
by

WIRE PRODUCTS Jelliff SINCE – 1880

THE C. O.
JELLIFF MFG. CORP.
28 Pequot Road
Southport, Conn.

LIST NO. 91 ON INFO COUPON PAGE 157

Insist on
Since 1923

CiRCO

METAL CLEANING EQUIPMENT
DEGREASING SOLVENTS

- VAPOR DEGREASERS
- METAL PARTS WASHERS
- STEAM CLEANERS

PER-SOLV (Perchlorethylene)
CIRCO-SOLV (Trichlorethylene)

Manufactured by
TOPPER EQUIPMENT COMPANY
Clark Township (Rahway) New Jersey

LIST NO. 10 ON INFO COUPON PAGE 157

PYROSIL

Electric Immersion Heaters

for METAL PICKLING & PLATING SOLUTIONS

Totally inert to all acids at any concentration except hydrofluoric
Sizes: 1000 to 10,000 Watts
PYROSIL, Inc.
CUYAHOGA FALLS, OHIO

LIST NO. 106 ON INFO COUPON PAGE 157

HOW TO DO BRIGHT GOLD PLATING *without scratch brushing or buffing!*

GOLD
SILVER
RHODIUM

Write for complete details

Sel-Rex

BRIGHT GOLD PROCESS

FOR INDUSTRIAL and DECORATIVE USES

1. Exceptionally hard deposits — twice the hardness of conventional gold plating.
2. Operates at room temperature — requires absolute minimum control.
3. Excellent metal distribution and "throwing power."

SEL-REX PRECIOUS METALS, INC.
Dept. BB, 229 Main Street
Belleville 9, N. J.

LIST NO. 108 ON INFO COUPON PAGE 157

Du-Lite

"Gives our tools Sales Appeal"

BARNABY MFG. CO. of Bridgeport, Conn., reports: "Our close proximity to salt water has given us problems in rust prevention for many years. We have experimented with many black oxide finishes but none has proven as successful, safe, and inexpensive as DU-LITE—our tools have better sales appeal—our volume has been on the increase ever since we started using this modern, progressive oxide finish."

Depend on Du-Lite, the metal-finishing specialists, for the most efficient and economical cleaners, black oxide finishes and phosphate coatings. Write for full details on:

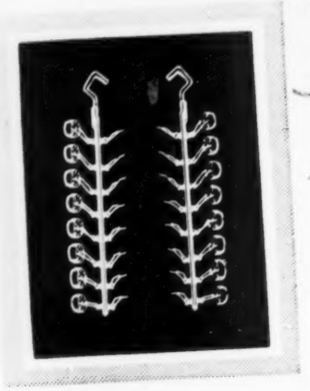
Du-Lite Black Oxide for Steel.
3-0 Black Oxide for stainless steel and malleable iron.
SD Compound for removing occluded salts.
Phosteel and Phospray for phosphatizing steel, iron or zinc.
Du-Lite Non-Acid Black Oxide for copper and copper alloys.
Dynakleen for bright cleaning all metals.
Kwikseal and Proctoil water displacing oils.

Or send us samples of parts and we will process them for your approval.

DU-LITE CHEMICAL CORP.
MIDDLETOWN, CONN.
Send more information on Du-Lite ☐
Send information on metal finishing products ☐
Have your representative call ☐
Name
Company
Address
City Zone State

Du-Lite
METAL FINISHING SPECIALISTS

LIST NO. 103 ON INFO COUPON PAGE 157



Got a Problem?

naraco

HAS THE ANSWER!

With skill and ingenuity, NARACO engineers designed this fuse rack to answer the difficult problem of perfectly plating nozzles and ventricles. Need help? Call your NARACO office today.

NARACO

AMERICAN RACK CO. 703 W. Root St. Chicago, Illinois
NATIONAL RACK CO. 179-181 Madison St. Paterson, N. J.
IMPERIAL RACK CO. 1109 E. Stewart Ave. Flint, Michigan
INDUSTRIAL RACK CO. 3462 San Fernando Rd. Los Angeles, Cal.

LIST NO. 14 ON INFO COUPON PAGE 157

WELDCO

FABRICATED MONEL PICKLING EQUIPMENT

• Hairpin Hooks • Sheet Crates

• Steam Jets • Chain

• Mechanical Bar, Tube and Coil Picklers

THE YOUNGSTOWN WELDING & ENGINEERING CO.

3728 OAKWOOD AVENUE • YOUNGSTOWN 9, OHIO

LIST NO. 94 ON INFO COUPON PAGE 157

Upton

. . . . OFFERS

the most advanced Salt Bath Furnaces

FOR . . . .

BATCH TYPE WORK

CONVEYORIZED TYPE WORK

ALUMINUM BRAZING

UPTON ELECTRIC FURNACE CO.
16808 Hamilton Avenue
Detroit, Michigan
Phone: Diamond 1-2520

LIST NO. 20 ON INFO COUPON PAGE 157

SWIFT BLACK!

. . . for Blackening

★ Single or Double Bath Process to meet Any Requirement

★ Faster, more Uniform Blackening

★ Quality Control Formula gives Efficiency of Production

★ Uniformity of Blackening Guarantees Economy

Send for FREE Literature on Swift BLACK and Cleaning Compounds TODAY!

Swift INDUSTRIAL CHEMICAL COMPANY CANTON CONNECTICUT

HEAT TREATING!

★ Carburizing Salts

★ Neutral Salts

★ Tempering Salts

Faster more fluid baths!

Free washing!

Send for FREE Literature TODAY!

Swift INDUSTRIAL CHEMICAL COMPANY CANTON CONNECTICUT

LIST NO. 92 ON INFO COUPON PAGE 157

TURBO TUBE *Agitator*

The economical efficient agitator for

- Quench Tanks
- Salt Baths
- Plating Tanks
- Pickling Tanks
- Subzero Coolants
- Waste Treatment

A high-speed marine-type propeller, located at base of bend, produces strong agitation of mix, upward and horizontally out of bend.

CHEMINEER, INC.
511 W. Second Street • Dayton 2, Ohio

LIST NO. 102 ON INFO COUPON PAGE 157

CIRC-AIR

HEAT TREATING FURNACES

for Every Heat Treating Process

★

CONTROLLED ATMOSPHERES

★

DIRECT FIRED

★

CIRC-AIR DRAW FURNACES

★

CIRC-AIR NICARB
(CARBONITRIDING)

Specially Engineered for Your Particular Needs

•

GAS • OIL • ELECTRIC

INDUSTRIAL HEATING EQUIPMENT COMPANY
3570 Fremont Pl. • Detroit 7, Mich.
Manufacturers of Industrial Furnaces Since 1917

LIST NO. 19 ON INFO-COUPON PAGE 157

SHERMAN INDUCTION HEATING EQUIPMENT

Megacycle Tube Type Machines

Soldering • Brazing • Bombarding
Annealing • Hardening

Sizes: Standard—2,4,10,25 KVA; Custom—to 100 KVA

Fast · Powerful · Reliable

Challenge Comparison—Value • Quality • Price • Design • Appearance

Free Trial Run of Your Sample Parts

Complete data, application photos, prices, delivery in New illustrated Catalog. Write on your company letterhead.

Since 1930... Pioneers in Megacycle Heating

SHERMAN *Industrial Electronics Company*
New York Area Office and Plant
505 Washington Ave., Belleville 9, N. J.

LIST NO. 18 ON INFO-COUPON PAGE 157

Serving the HEAT TREATING INDUSTRY *Since 1930*

- Complete Service on Control Equipment
- Thermocouples
- Protection Tubes
- Charts and Lead Wire

THE CLEVELAND ELECTRIC LABORATORIES COMPANY

1988 E. 66 St.
Cleveland 3, Ohio

LIST NO. 32 ON INFO-COUPON PAGE 157

DEMPSEY FURNACES

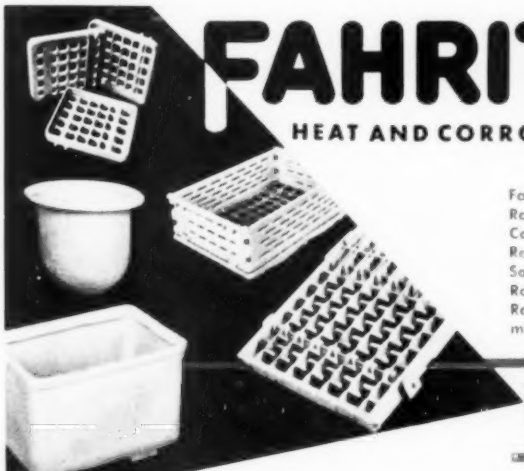
GAS, OIL AND ELECTRIC
BATCH • CONTINUOUS

ATMOSPHERIC - RECIRCULATING - PUSHER — ROTARY HEARTH — CONVEYOR — RADIANT TUBE — POT CAR-BOTTOM — ALUMINUM REVERBS.

"Tailored by Dempsey"

DEMPSEY INDUSTRIAL FURNACE CORP.
Springfield 1, Mass.

LIST NO. 79 ON INFO-COUPON PAGE 157



FAHRITE
HEAT AND CORROSION *Alloys*

Fahrite is used for:
Rails • Trays • Carburizing Boxes • Retorts • Chain Solution Pots • Rollers • Muffles • Radiant Tubes • many other products

district offices
BIRMINGHAM, ALA.
CHICAGO, ILLINOIS
TOLEDO, OHIO
CLEVELAND, OHIO
DETROIT, MICHIGAN
HOUSTON, TEXAS
NEW YORK, N. Y.
PHILADELPHIA, PA.
PITTSBURGH, PA.
ST. LOUIS, MISSOURI
SAN FRANCISCO, CALIF.
CINCINNATI, OHIO
TULSA, OKLAHOMA

THE OHIO STEEL FOUNDRY CO.
SPRINGFIELD, OHIO — Plants at Lima and Springfield, Ohio

ENGINEERS FOUNDERS FABRICATORS METALLURGISTS

LIST NO. 97 ON INFO-COUPON PAGE 157

LET'S PUT OUR HEADS TOGETHER...

TO GET THE HEAT TREATING CONTAINERS YOU WANT!

Tell Stanwood Engineers your particular problem—**type of parts you are heat treating—furnace capacity—cycle, etc.** With our broad experience and production **facilities we can supply** baskets, trays, fixtures, carburizing boxes, retorts **or furnace parts to** exactly meet your needs—economically too! Send for **literature.**

Representatives in Principal Cities

Stanwood S Corporation

4817 W. Cortland St. Chicago 39, Ill.

LIST NO. 12 ON INFO COUPON PAGE 157

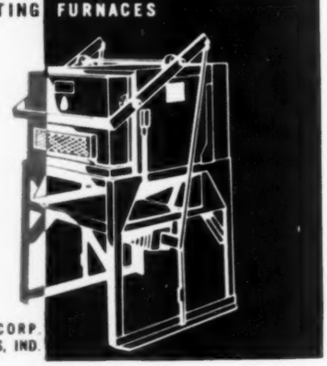
Expand Your Plant Potential

WITH *Cooley* ELECTRIC HEAT TREATING FURNACES

fast . . . inexpensive way to expand your plant facilities. Choose from 27 Models.

For Instance:

1. You save time and money by keeping heat treat jobs for small parts in plant.
2. It's easy to establish a new department at small cost in proportion to benefits which result.
3. Cooley heat treat furnaces pay for themselves through savings in time and subcontracting costs.
4. Heat treat operations are easily performed with Cooley designed furnaces.



Write now for Catalog giving complete details.

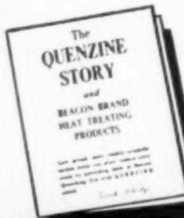
Cooley ELECTRIC MANUFACTURING CORP.
38 SO. SHELBY ST. • INDIANAPOLIS, IND.

LIST NO. 87 ON INFO COUPON PAGE 157

FREE

the QUENZINE STORY

Low priced, more readily available carbon steels can often replace alloy steels when quenched in Beacon Quenching Oils with QUENZINE added. For information on this new additive and other Beacon Brand Heat Treating Compounds write to . . .



ALDRIDGE INDUSTRIAL OILS, Inc.

3401 W. 140th St., Cleveland 11, Ohio

LIST NO. 29 ON INFO COUPON PAGE 157

EXPLOSION COMBINATION GAS and OIL BURNER

for
HEAT TREAT
FORGING
MELTING

Our burners afford fuel savings, complete combustion (11½% CO_2 Orsat), controlled atmosphere, instant lighting, complete heat ranges. Simple installation and control. Rapid conversion from gas to oil. Also patented refractories in special shapes.

Ra-DIANT PRODUCTS CO.

1413 W. Tuscarawas Street
Box 729 Canton, Ohio

LIST NO. 80 ON INFO COUPON PAGE 157

INDUSTRIAL FUEL BURNING EQUIPMENT..

Designed **FOR YOUR SPECIFIC REQUIREMENTS**

- Motor-Mix Burners
- Model DA Mixers
- Western Safety Valves
- Injector-Mix Burners
- Flame Retention Nozzles
- Accessories
- Inspirator-Mix Burners
- Blowers
- Multiport Burners
- Custom Built Equipment

Free descriptive literature on request

WESTERN PRODUCTS

WESTERN PRODUCTS, Inc.

General Office New Castle, Ind. — 549 W. Washington Blvd. Chicago 6, Ill.

LIST NO. 93 ON INFO COUPON PAGE 157

BELLIS

- 35 years experience designing and manufacturing Salt Bath Furnaces.
- Originators and pioneers of ELECTRODE FURNACES including these patented features:
  1. Water Cooled Electrodes
  2. Starter Coil
- Salts for all heat treating applications (300 to 2300 F.°) supplied by the CROWN CHEMICAL DIV.

THE BELLIS CO.
BRANFORD, CONN.

LIST NO. 96 ON INFO COUPON PAGE 157

Instruments and controllers for heat treating furnaces

A complete summary of Hays products applicable to processes such as annealing, brazing and calorizing. Scope includes various methods of firing (underfired, overfired, sidefired), fuel burned (gas, coal, oil), and type of furnace (continuous, rotary hearth, slab heating, etc.).

Hays complete line of draft gages, flow gages and meters (for high and low pressure gases and liquids), portable gas analyzers and automatic CO₂ recorders are covered.

Write for bulletin 51-750-51

THE HAYS CORPORATION
Michigan City 26, Indiana

LIST NO. 30 ON INFO COUPON PAGE 157

Plan to Attend

the

METAL SHOW

Cleveland

October 19 to 23

1953

RICHARDS
PYROMETER SUPPLIES

Control Temperatures More Closely
Reduce Cost — Save Time

Catalog No. 5 shows you how! Get your free copy today!

- Thermocouples • Protection Tubes
- Thermocouple Wire • Lead Wire
- Insulators • Terminal Heads

Low prices for top quality
Prompt shipment from stock

ARKLAY S. RICHARDS CO., Inc.
74 Winchester St.
Newton Highlands 61, Mass.

LIST NO. 31 ON INFO COUPON PAGE 157

Spotlighting
DETROIT'S BETTER
HEAT TREATER

OFFERING FACILITIES FOR:

1. **ALUMINUM**-CAP. 500,000# PER MO.
2. **MINUTE PARTS** TO 2-TON DIES
3. **BRIGHT HARDENING** OF STAINLESS STEEL

ALL TYPES OF HEAT TREATING CAN BE DONE BETTER BY

STANDARD STEEL TREATING CO.
3467 LOVETT AVE. DETROIT 10, MICH.
Phone TAshmoo 5-0600

LIST NO. 40 ON INFO COUPON PAGE 157

"Know-How" is one thing . . . DOING IT BETTER is what counts!

Whether it's the treating of your rough forgings, castings and bar stock, or your finish-machined parts, you can depend on Lakeside to do it better. From the unbiased, scientific recommendations of your Lakeside metallurgists; through the perfected, fully mechanized, electronically-controlled processes to instrumented, precision testing; Science directs every step. No chance for guesswork, or human error. Only with the finest, modern facilities can you be assured of highest steel treating quality.

THE *Lakeside Steel Improvement Co.*
3418 LAKESIDE AVE., CLEVELAND 14, OHIO HENDERSON 1-9100

LIST NO. 43 ON INFO COUPON PAGE 157

JUST PUBLISHED...

THE STORY OF MALCOMIZING

(for surface hardening stainless steels)

what it is . . what it does . . how it works . . how you can use it.

Write today for your copy of this 24-page booklet. Specific subjects discussed include . . . pretreating the steels . . . selective Malcomizing . . . case depth . . . wear resistance . . . corrosion resistance . . . passivation of Malcomized steels.

A special "case history" section shows how nationally known manufacturers are specifying Malcomizing for the surface hardening of stainless steels.

Lindberg Steel Treating Co., covering industrial America from coast to coast, with plants in Rochester, Chicago, St. Louis and Los Angeles, is now licensed to Malcomize for its customers. For particulars call your nearest Lindberg plant.

LINDBERG STEEL TREATING COMPANY

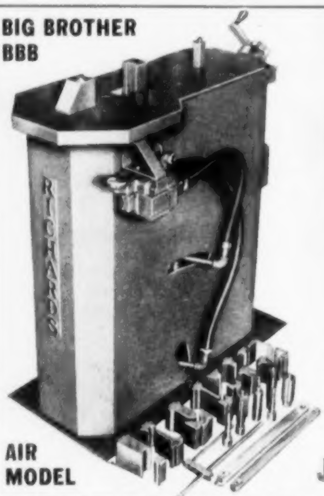
Chicago 7, Illinois, 222 N. Laflin, Phone: MOnroe 6-3308. St. Louis 15, Missouri, 650 E. Taylor, Phone: Fireside 6300. Los Angeles 23, 2910 South Sunol Drive: Angelus 9-7311; Rochester 11, 620 Buffalo Road, Phone: GEnesee 5212.

CHICAGO • LOS ANGELES • ROCHESTER • ST. LOUIS

LINDBERG STEEL TREATING CO.

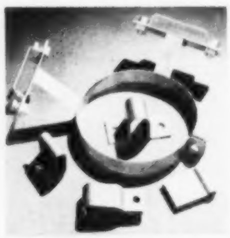
LIST NO. 38 ON INFO-COUPON PAGE 157

BIG BROTHER
BBB



AIR
MODEL

Multiform



Illustrated above are a few of the many forms that can be produced efficiently on the Multiform Bender, using the standard tooling.

WRITE TODAY FOR FULL INFORMATION

BENDERS-CUTTERS 20 MODELS

FOR BENDING ALL KINDS OF MATERIALS up to ¼" x 4"

GREAT SAVINGS

#5HDSB

Also build #5 AIR MODEL

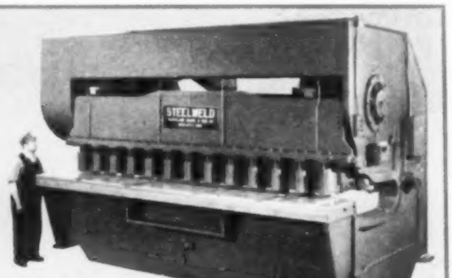
J. A. RICHARDS CO. • 913 N. Pitcher St. • Kalamazoo, Michigan

LIST NO. 107 ON INFO-COUPON PAGE 157

STEELWELD PIVOTED BLADE SHEARS

Radically Different

Steelweld metal-cutting shears are entirely new with advantages never before possible. Revolutionary pivoted-blade travels in circular path and overcomes handicaps of ordinary guillotine-type shears. No slides or guides to wear and cause inaccuracies. Many other important features. Complete line machines for shearing metal up to 20 feet long or in thicknesses to 1-1/4 inch.



FEATURES GALORE

1. All-welded solid one-piece frame.
2. Electric foot control.
3. Fast Micro-Set Knife Adjustment.
4. Deep throat for wide slitting.
5. Lift-up Back Gauge.

Straight Accurate Cuts

Not only are these machines easier to operate but their design assures smooth straight cuts to hair-line accuracy for years of operation. Their construction is extra heavy, and all modern features are incorporated to provide for ease of operation, minimum maintenance and long life.

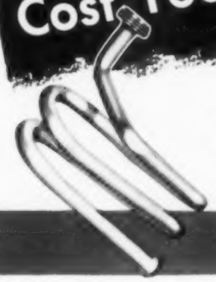
WRITE FOR CATALOG No. 2011.

THE CLEVELAND CRANE & ENGINEERING CO.

5939 East 282nd Street • Wickliffe, Ohio

LIST NO. 59 ON INFO-COUPON PAGE 157

How Much Does CORROSION Cost Your Plant?



This is Illium welded tubing. Easily bent and flared to exact tolerances, it retains a bright finish in service.

Specify ILLIUM Consruction to Stop Corrosion Losses PERMANENTLY

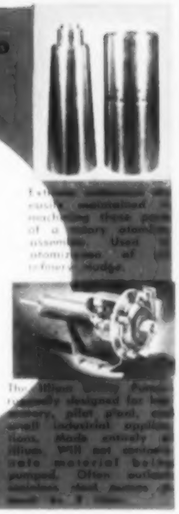
If your product or plant must handle sulfuric . . . nitric . . . phosphoric . . . mixed acids . . . or acid-salt solutions, you can profit by using Illium.

More than 30 years of use in critical processing operations have proved Illium unsurpassed in handling these highly corrosive acids both liquids and gases at virtually all concentrations and temperatures. In addition, it also serves to resist erosion and heat equally well.

Ideal for use in the drug, dairy, chemical and food industries because it lends itself so perfectly to sanitary construction. Other outstanding uses have been found in petroleum processing, ordnance work, and many marine applications.

Available in castings up to 575 lbs., Illium is easily machined and welded. Samples for testing and investigation will be sent upon request.

write for Bulletin 651 for Complete Data



THE ILLIUM CORPORATION, FREEPORT, ILLINOIS

Makers of Special Alloys and Quality Castings for Industry

LIST NO. 104 ON INFO-COUPON PAGE 157

DON'T GET BEHIND IT–

Avoid PREVENTABLE ACCIDENTS

NATIONAL SAFETY COUNCIL

WRITE, WIRE or PHONE FOR YOUR CATALOG *Today*

BOLTS & CAP SCREWS

SOCKET, SET & CAP

NUTS, WASHERS

MACHINE SCREWS

SHEET METAL SCREWS

WOOD SCREWS

PIPE FITTINGS

Star STAINLESS SCREW CO.

ARmory 4-1240

218 Union Avenue • Paterson 2, N. J.

Direct NEW YORK Telephone: WI 7-9041

LIST NO. 99 ON INFO-COUPON PAGE 157

ARDCOR *Engineered*

TUBING ROLLS AND FORMING ROLLS

To Your Specifications or Ardcor Design — for all makes of machines

ARDCOR ROLLER DIES ● ROLL FORMING MACHINERY ● CUT-OFF MACHINES

American ROLLER DIE CORPORATION

20680 St. Clair Avenue • Cleveland 17, Ohio

LIST NO. 57 ON INFO-COUPON PAGE 157

• write for your Design Imagineering Folder . . . on company letterheads, please.

RIGIDIZED METALS CORPORATION

Ohio St., Buffalo 3, N.Y.

U.S. & Foreign Patents

50 Warehouses & Sales Representatives in All Principal Cities Throughout the U.S. & Canada

LIST NO. 64 ON INFO-COUPON PAGE 157

USE OUR

HOEGANAES
SPONGE IRON POWDER

for

Powder Metallurgy
Fabrication
and other
Metallurgical Purposes

EKSTRAND & THOLAND, Inc.
441 Lexington Avenue
New York 17, N. Y.

LIST NO. 63 ON INFO-COUPON PAGE 157

"SILVERCOTE"®
BERYLLIUM COPPER

BRONZES • ALUMINUM
COPPERWELD • SILVER PLATED WIRES
OTHER NON-FERROUS

ROUND **WIRE** FLAT

for

- SPRINGS
- FORMS
- ELECTRONICS
- SPECIAL PURPOSES

LITTLE FALLS ALLOYS
INCORPORATED
189 Caldwell Ave. • Paterson 1, N. J.

LIST NO. 66 ON INFO-COUPON PAGE 157

WHITELIGHT
MAGNESIUM

your comprehensive independent source of magnesium alloy
Tubes • Rods • Shapes • Bars
Hollow Extrusions • Plate • Strip
• Pipe • Wire • Welded and Riveted structures and assemblies

WHITELIGHT MAGNESIUM

WHITE METAL ROLLING & STAMPING CORP.
82 Moultrie St., Brooklyn 22, N. Y.
Sales Office
376 Lafayette St., New York 3, N. Y.

LIST NO. 67 ON INFO-COUPON PAGE 157

MAURATH INC.

MANUFACTURERS • PROCESSORS
OF STAINLESS
AND HEAT RESISTANT
ARC WELDING
ELECTRODES

★ ★

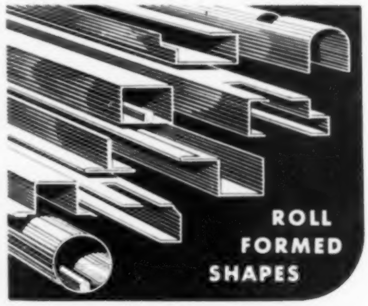
AUTOMATIC WELDING

ALL ANALYSES—COATED,
STRAIGHTENED AND
CUT, OR COILED

Telephone:
MOntrose 2-6100

LIST NO. 72 ON INFO-COUPON PAGE 157

LIST NO. 83 ON INFO-COUPON PAGE 157



Reduce your assembly problems and costs. Our shapes continuously formed, with high degree of accuracy, from ferrous or non-ferrous metals. Write for Catalog No. 1053.

ROLL FORMED PRODUCTS CO.

MAIN OFFICE AND PLANT
2761 OAKWOOD AVE. • YOUNGSTOWN, OHIO

LIST NO. 101 ON INFO-COUPON PAGE 157

GET A BID FROM

HOOVER

SPECIALISTS IN THE FIELD OF
Die Castings
SINCE 1922
Aluminum and Zinc

THE HOOVER COMPANY
Die Castings Division
North Canton, Ohio

LIST NO. 74 ON INFO-COUPON PAGE 157

Use Atlantic Fluxes

ALUCO . . .
For degasifying and purifying aluminum alloys. Assures uniformly sound, dense grained castings. Used in reverberatory and crucible-type furnaces.

ALUCO 'S' . . .
Specially compounded for die casting aluminum-base metal and permanent mold castings.

MAGNESAL . . .
Used for removing magnesium from aluminum alloys.

ALUCO 'GR' & 'DG' . . .
For grain refining and degasifying aluminum and its alloys.

Atlantic Chemicals & Metals Co.
1921-27 NORTH KENMORE AVE.
CHICAGO 14, ILLINOIS, U.S.A.

LIST NO. 84 ON INFO-COUPON BELOW

Alexander
SHEET METAL TESTER
For Erichsen Test

Determines workability of ferrous, non-ferrous and fine metal sheets and strips to point of fracture. Reading—accurate to 0.0004" . . .

Write for Catalog

J. ARTHUR DEAKIN & SON
150-28 Hillside Ave. • Jamaica 2, N. Y.

LIST NO. 89 ON INFO-COUPON PAGE 157

Do you have trouble

Tapping
Broaching
Milling
Drilling
Reaming
Drawing

the new high temperature heat, corrosion-resistant alloys and stainless steels?

IF SO . . .

Call or write for particulars concerning the unique coolants SUPER ALKUT and SUPER AL-DRAW. Far better finishes and greatly increased tool life have been obtained with these products by many large metal-working firms over the last ten years.

HANGSTERFER'S LABORATORIES, Inc.
21 Cooper St. :-: Woodbury, N. J.

LIST NO. 85 ON INFO-COUPON PAGE 157

RUST-LICK
IN
AQUEOUS SYSTEMS

For
HYDROSTATIC TESTING

Eliminates . . . .
Rust
Fire Hazards
Toxicity
Dermatitis
Washing

WRITE FOR FREE SAMPLE & BROCHURE

PRODUCTION SPECIALTIES, INC.
755 BOYLSTON STREET
BOSTON 16, MASS.

LIST NO. 105 ON INFO-COUPON PAGE 157

Cut Costs With
FREE
Cutting Oil Chart

Use this free cutting oil chart as a handy guide to production costs and to more efficient machining operations.
Steel and nonferrous metals are charted with the proper cutting oil for many applications. Shows you how to use lubricants, sulphurized or compounded with extreme pressure additives, for all operations.

KELCO

ALDRIDGE INDUSTRIAL OILS, Inc.
3401 W. 140th St., Cleveland 11, Ohio

LIST NO. 100 ON INFO-COUPON PAGE 157

ASK BODER for all kinds of LABORATORY FURNACES

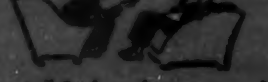
HIGH FREQUENCY COMBUSTION UNITS

Thermocouple Checking
Automatic Type
Tube Types — 2000-5000° F.
Box Types — 2000-3000° F.
Heat Treating
Salt Bath Tempering
Melting by Carbon Arc

Metallurgical Experiments
Atmosphere Annealing
Powder Metallurgy
Hardenability Test
Combustions
Carbon & Sulfur Det.
High Frequency Fusion

BOX TYPE FURNACES

Ask for Catalog 5201-B



You tell Boder what you need.

BODER SCIENTIFIC COMPANY

LIST NO. 55 ON INFO-COUPON PAGE 157

TESTING-ANALYZING

Send that small job to us now. It will become a part of our daily routine. We encourage small jobs so you will become familiar with our laboratories. —The large jobs will follow.

- METALLURGY
- APPLIED MECHANICS
- CHEMISTRY
- NON-DESTRUCTIVE TESTING

Extensive facilities. Many years of experience. Services available at regular rates.

ST &CO., INC.

SAM TOUR & CO., INC.

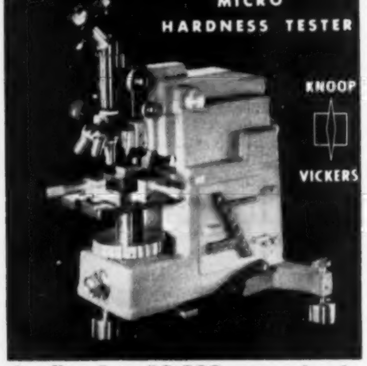
AMERICAN STANDARDS TESTING BUREAU, INC.

TESTING LABORATORIES

LIST NO. 35 ON INFO COUPON PAGE 157

KENTRON

MICRO HARDNESS TESTER



Applies 1 to 10,000 gram loads

Write for Bulletin

KENT CLIFF LABORATORIES

PEEKSKILL NEW YORK

LIST NO. 53 ON INFO COUPON PAGE 157

MERIAM

MANOMETERS

U-TYPE • WELL TYPE • DUAL TUBE

FLOW METERS
DRAFT GAUGES

For measuring pressure, vacuum and differential pressure of liquids and gases. Also a complete line of accessories.

ASK FOR CATALOG C-12

THE MERIAM INSTRUMENT CO.
10932 MADISON AVE.
CLEVELAND 2, OHIO

U-TYPE MANOMETER

LIST NO. 48 ON INFO COUPON PAGE 157

Inspection Demagnetizing or Sorting PROBLEMS?

SOLVED with ...

"MAC" MULTI-METHOD EQUIPMENT Electronic Equipment for non-destructive production inspection of steel bars, wire rod, and tubing for mechanical faults, variations in composition and physical properties. Average inspection speed 120 ft. per minute.
Over 50 steel mills and fabricators are now using this equipment.

"MAC" DEMAGNETIZERS Electrical Equipment for rapid and efficient demagnetizing of steel bars and tubing. When used with "MAC" Multi-Method Equipment, inspection and demagnetizing can be done in a single operation.

"MAC" COMPARATORS Electronic Instruments for production sorting both ferrous and non-ferrous materials and parts for variation in composition and physical properties.

"MAC" MAGNETISM DETECTORS Inexpensive pocket meters for indicating residual magnetism in ferrous materials and parts.

FOR DETAILS WRITE: MAGNETIC ANALYSIS CORPORATION
42-44 Twelfth Street Long Island City 1, N. Y.

LIST NO. 51 ON INFO COUPON PAGE 157

HERE'S HELP for your engineer-recruitment problem

Engineers' Joint Council and The Advertising Council offer free, expert help to advertisers promoting engineering as a career.

A booklet has been prepared by The Advertising Council in cooperation with the Engineers' Joint Council to help you in recruiting engineers for the future.

1. It tells you what the problem is and the important part you can play in solving it.
2. It outlines the advantages of an engineering career to help your company develop advertising appeals.
3. It informs you as to the current activities of industry in the education and recruitment of engineers.
4. It offers specific suggestions as to what you can do (from present manpower).
5. It provides material that you can use in your own local and national programs.

Many companies are using this booklet today. They say that it helps in orienting their engineer-recruitment advertising to industry-wide recruitment programs. Send for the booklet now. Address: The Advertising Council, Inc., 25 West 45th St., New York 36, N.Y.

This space contributed by American Society for Metals

If you want to perform
Tensile or Brinell testing operations
quickly and simply—*contact*

Detroit Testing Machine Company
9390 Grinnell Ave. • Detroit 13, Mich.

LIST NO. 54 ON INFO-COUPON BELOW

ULTRASONICS

for rapid, accurate, non-destructive
THICKNESS MEASUREMENTS
and FLAW DETECTION **from one side**

AUDIGAGE® Thickness Testers
Ranges: 0.020" to 4", and 0.060" to 12".

AUDIGAGE® Ultrasonic Micrometer
Direct-reading; Special ranges as required;
Accuracy as high as ±0.25%.

CRYSTALS: Standard and special mountings; internal ground returns; high-temperature operation.

BRANSON INSTRUMENTS, INC.
electronics
development
production
439 FAIRFIELD AVE • STAMFORD • CONN.

Literature on Request

LIST NO. 81 ON INFO-COUPON BELOW

NOTCH-COIL RINGS UP SILVER BRAZING 800%

Stress-relieved notch-coil preforms snap off coil, snap snugly around refrigerator gas strainers in one time-saving motion.

L-M predetermined ring sizing speeds assembly work! Rings and preforms fit quickly and accurately on parts to be joined. THERE IS NO WASTE! !

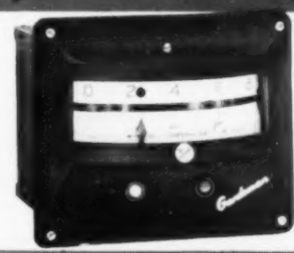
Regardless of what your joining and silver brazing operations are it will pay you to consider *L-M Silver Brazing Preforms.*
Above manufacturer and details available upon request

FREE **VALUABLE BRAZING PRODUCTION DATA.**
WRITE, PHONE OR WIRE TODAY

LUCAS-MILHAUPT
ENGINEERING CO.
5051 S. Lake Dr., Cudahy, Wis.

LIST NO. 46 ON INFO-COUPON AT RIGHT

Specify **Gardsman** *by* **WEST**
for Precision and Reliability in Temperature Control



The complete line of GARDSMAN temperature controllers made by WEST includes On-Off Controllers, High Limit, Proportioning, Three Position, Program, Portable Temperature, and Stepless Controllers.

Gardsman instruments are famous for reliability and precision throughout the industries of the world... the magnetic amplifier principle eliminates all adjustments and tube replacements.

Write today for detailed Bulletins.

WEST *Instrument* CORPORATION
FORMERLY TACO WEST CORPORATION

527 N. NOBLE ST. CHICAGO 22, ILL.

LIST NO. 98 ON INFO-COUPON BELOW

READERS' INFO-COUPON SERVICE, METAL PROGRESS
7301 Euclid Avenue, Cleveland 3, Ohio

Please send further information, as checked at the right, on the advertisements in the Bulletin Board with numbers I have listed below—

(Bulletin Board Item Number)	Send Catalog or Engineering Data	Send Price Info	Nearest Source of Supply
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐

(Please check)

Your Name ______ Title ______

Company ______

Street ______

City ______ Zone ______ State ______

Reeves 1911 Octoauto, made at Columbus, Ind. Advertised as "the only car in the world built on the principle of a Pullman Palace-Car."

Alloy steels have changed, too!

Today's alloy steels are as different from the steels of 1911 as today's automobiles are from the ancient Octoauto.

Among the Vancoram alloys which have helped make this possible is Vancoram **HIGH CARBON FERROCHROMIUM.** This is the Vancoram alloy used to produce top-quality chromium steels for scores of wrought and cast constructional parts . . . chromium steels specified, for example, by the automobile industry for bearings and axles, gears and shafts, springs and steering parts.

Vancoram **HIGH CARBON FERROCHROMIUM** imparts to steel improved mechanical properties, greater resistance to heat and corrosion, increased response to heat treatment. Produced by the most advanced methods, it is exceptionally free from foreign inclusions. It can be supplied in lump or crushed form, or in sizes ground to specification.

Get the complete story on Vancoram **HIGH CARBON FERROCHROMIUM.** Call your nearest Vanadium Corporation office at your earliest opportunity.

Other Vancoram alloys for the iron and steel industries include a complete range of vanadium, titanium and silicon alloys, as well as a variety of special foundry alloys.

Producers of alloys, VANCORAM BRAND metals and chemicals

VANADIUM CORPORATION OF AMERICA

420 Lexington Avenue, New York 17, N. Y. DETROIT · CHICAGO · PITTSBURGH · CLEVELAND

MAKE IT BETTER . . . MAKE IT ALLOY!

Q-ALLOYS THE QUALITY NAMES IN ALLOY FOR HEAT CORROSION ABRASION X-ite

DON'T LICK 'EM — TEASE 'EM!

While this is written, "UN" strives to conclude a scurvy "Peace" to mark a Moral and Military Defeat *without precedence in U.S. History*. Our "Diplomats", and our "Allies", *not* the Enemy, have *denied Victory to U.S. Arms!* Some secret connivance with "Allies" to buy temporary security for their Chinese interests appears to have been inherited by Eisenhower. Otherwise, why not bomb out Chinese Communist industry and transport? WHO wants to save their armories—and WHY?

Anyway — WE'RE TEASIN' 'EM — but HARD!

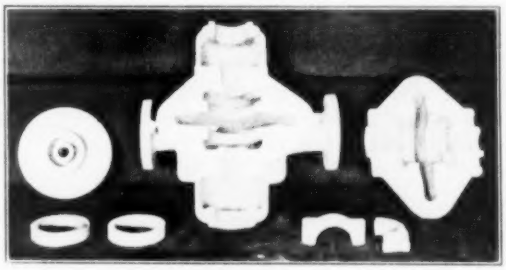
Leaflet, officially entitled "No Sweethearts for the CCF", Serial No. 8727—here reproduced—comprised part of the tissue "Distributed to Chinese Communist Forces on Eighth Army Front under Plan Divide, designed to stimulate longing for female companionship and create dissension". The Chinese text reads: "When will you see your Sweetheart again?"

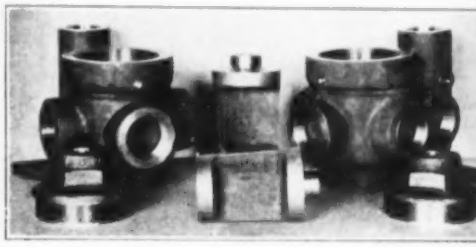
Psychological Warfare Division, G3, found that Model on the wrong side of the lines, no yen for the mud-hens on the wooden plows will grip Chinko when he eyes that! He'll start running SOUTH, not North.

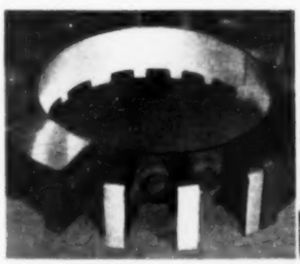
Newsreels of the Rosenberg traitors' stage-managed funeral should be shown to G.I.'s in Korea. They might recognize some neighbors in the procession, and bring them some "souvenirs". It takes a moron or a traitor to shed a tear for those who plot destruction of their country by selling atomic secrets to the Enemy.

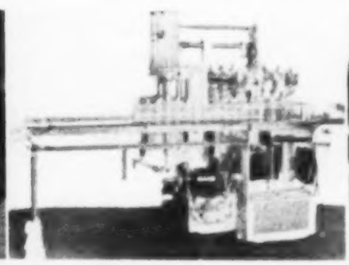
An "Aditorial" by the President of GENERAL ALLOYS COMPANY, "Oldest and Largest exclusive Mfrs. of Heat & Corrosion Resistant Castings", Boston, Mass. Offices & Representatives in principal cities.

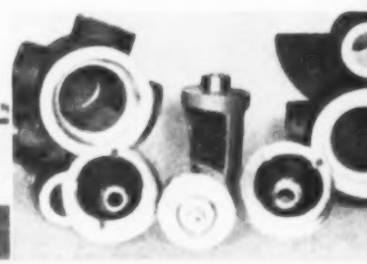
General Alloys uniquely combines Engineering Design, Metallurgy, and Advanced Casting Process, integrated in our Product, and PROVEN,—by the RECORDS of users in the most severe service installations. General Alloys extensive Research and Development, in the advancement of U.S. Casting Process, forms the principal base, and a major part of current advancement of "High Integrity" castings. The castings shown, in "Stainless Steels" and Super-Corrosion Resistant Alloys, may suggest possible G.A. applications in your operations. An inquiry will bring a G.A. Engineer, backed by 35 Years of EXPERIENCE.











THE FOOTSTEPS OF GENERAL ALLOYS MARK THE PATH OF AN INDUSTRY

Now— ALUMINUM SOLDERING MADE EASY!

A Universal Flux For All Commercial Metals Usually Joined By Soldering

WIRE SX PRODUCTS

Aluma-Flux SOLDERING FLUX

Manufactured By
ESSEX WIRE CORP.
Ft. Wayne, Ind.

Here at last is the only flux ever developed that makes possible the _non-corrosive_ joining of all types of aluminum alloys by any soldering method—manual, dip or mechanical. No cleaning is required after soldering is accomplished—Aluma-Flux leaves no corrosive residue—soldered pieces are ready for use immediately.

S-X Aluma-Flux is equally effective for soldering stainless steel, bare and galvanized carbon steel, cast iron and other ferrous alloys, copper, brass and nickel—all commerical metals commonly joined by soldering. The joining of aluminum to brass; the coating of copper with tin; and the soldering of other unlike metals is made fast and easy with Aluma-Flux.

Soldered joints in aluminum produce no corrosive action due to flux residue when exposed to salt-spray, high humidity, alkaline water, etc. Aluma-Flux shows no detrimental effect on any soldered joint.

S-X Aluma-Flux can be used with 100% satisfactory results in powdered form as delivered, or in molten form—whichever is most efficient for the job. Virtually any type of solder can be used. Aluma-Flux can be stored indefinitely without change of weight, or any impairment of fluxing efficiency. Being non-hygroscopic, it will not absorb water.

In addition to its exceptional fluxing characteristics, Aluma-Flux offers many other cost-reducing, time-saving advantages . . .

The success of S-X Aluma-Flux in the soldering of aluminum is due to the action in which the flux initially reduces surface oxides and then immediately deposits a thin layer of plating material on the solder area. Oxidation of the area to be soldered is thus prevented while the plating material serves as an approved base on which to solder. In addition to its soldering efficiency, Aluma-Flux reacts completely during the joining operation so there are no corrosive flux residues to lower corrosion resistance of the finished joint.

ALUMA-FLUX IS READY FOR IMMEDIATE SHIPMENT IN CONVENIENT SIZE METAL CONTAINERS.

Write Today For Complete Details

Distributed Only By

INSULATION and WIRES incorporated

1535A Swinney Avenue • Ft. Wayne 6, Indiana

Copyright 1953 by Insulation and Wires Incorporated, St. Louis, Mo.

"Elastic Reserve" Is Key to Wrapped Wire-Terminal Joints

A Review by A. H. ALLEN, Technical Business Consultant, Cleveland*

JOINING WIRES to apparatus terminals for conduction of current is basic to the manufacture of all types of communications equipment and electronic devices. The number of connections made annually runs to an astronomical figure. The Bell Telephone System alone estimates its total close to one billion; radio and television manufacturers ten billion. Others must account for additional billions.

For trouble-free operation and durability, soldering has been the long-established method for making these joints. Good as it is, the method has obvious drawbacks – soldering splashes, damage to heat-sensitive elements in circuit components, contamination from fumes and the limits of manual dexterity in handling a hot soldering iron.

Other methods of wire-terminal connection are of the pressure type, with the exception of some scattered applications of welding or brazing. Six typical pressure connections are evaluated in Table I for the seven principal requirements of this type of connection. The solderless mechanically-wrapped joint, which meets all seven requirements, is an entirely new technique developed by engineers of the Switching Apparatus Division, Bell Telephone Laboratories, and the subject of exhaustive research and tests on their part. Briefly, it involves a mechanical means for wrapping the bared end of a wire seven times around a rectangular-shaped terminal tightly enough so that the wire will be indented by the corners of the terminal and adhere thereto by virtue of "elastic reserve" in the wire and surface diffusion of the contacting metals.

What follows is an appraisal of the solderless wrapped connection, comparison with other pressure joints, and principles involved.

*A consolidated review of reports on the design, analysis and tests of solderless wrapped connections, by J. W. McRae, R. F. Mallina, W. P. Mason, T. F. Osmer and R. H. Van Horn, all associated with the Bell Telephone Laboratories Inc., Murray Hill, N. J. Text and illustrations are presented through courtesy of A. C. Keller, director of the laboratories' Switching Apparatus Div.

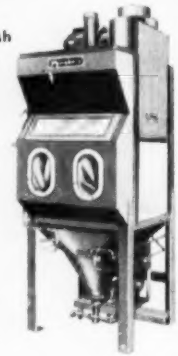
Table I – Comparison of Pressure Joints

Requirements	Type of Joint					
	Fahnestock Clip	Plug	Crimp	Wire Nut	Screw	Solderless Wrapped
Large contact area			√	√	√	√
High contact force			√	√	√	√
Long life			√	√	√	√
Small size		√	√			√
Mechanically stable			√		√	√
Easily disconnected	√	√		√	√	√
Low cost						√
Properties of Joint*	No. 15	0.040 In. Dia. Pin	0.120 In. Dia. × 0.112 In. Long	0.350 In. Dia. × 0.550 In. Long	No. 4-40 (0.112 In.)	0.0148 × 0.062 In. Terminal
Contact force, in lb.	1.4	2.2	22	Unknown	135	90
Contact area, in sq.in.	0.000079	Unknown	Unknown	Unknown	0.0074	0.0031
Contact pressure, in psi.	18,000	Unknown	Unknown	Unknown	18,250	29,000
Space needed, in 10^6 cu. mils	41	8.78	1.75	52.8	15.6	1.53
Elastic energy, in mil-lb.	21	Unknown	Unknown	Unknown	2.77	3.05

*For No. 24 (0.020-in.) wire.

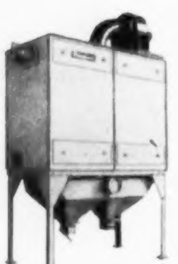
PANGBORN SPEEDS UP PRODUCTION, LOWERS COST

WITH PRECISION FINISHING . . .



Pangborn Hydro-Finish Cabinet—Removes scale and directional grinding lines . . . holds tolerances to .0001" and prepares surfaces for painting or plating. Liquid blast reduces costly hand cleaning and finishing of molds, dies, tools, etc. Models from . . . **$1410** and up.

AND DUST CONTROL



Pangborn Unit Dust Collector—Traps dust at the source. Machine wear and tear is minimized, housekeeping and maintenance costs reduced. Solves many grinding and polishing nuisances and allows reclamation of valuable material. Models from . . . **$286** and up.

Pangborn Blast Cleaning Machines for cleaning tanks, bridges, structures quickly and economically. Portable and stationary models, 6 sizes . . . $188 and up. Cabinet for cleaning small metal parts better and faster . . . $319 and up.

Write for details on these machines to: PANGBORN CORPORATION, 1800 Pangborn Blvd., Hagerstown, Md.

Look to Pangborn for the latest developments in Blast Cleaning and Dust Control equipment

Pangborn

STOCK UNITS

Wrapped Wire - Terminal Joints

This discussion, incidentally, centers around wrapped connection of a No. 24 (0.020 in. diameter) single-strand copper wire to a rectangular terminal measuring about 0.060 × 0.020 in. First in importance is the effective contact area relative to the cross-sectional area of the wire, since this controls the resistance of the connection. For efficient service this area must remain uniform in size, metallically bright and be unaffected by temperature changes, vibration, handling or corrosion. An effective contact area requires that the two metal parts be pressed together with a force high enough to lock intimately all particles of the area and to insure freedom from insulation impurities. If the pressure is high enough, any oxide film on the terminal will be crushed and dissipated. In a good connection contact area is generally at least equal to the cross-sectional area of the wire. In screw, crimped and wrapped joints, it is a multiple of the wire section.

If electrical resistance of a pressure joint is to hold constant with time – 40 years is considered a reasonable life expectancy for telephone equipment – the contact area must remain constant, but not necessarily the contact force. Once metal particles are tightly interlocked, a subsequent reduction in contact force, within relatively wide limits, does not change electrical resistance. Enough force to sustain "gas tightness" of the joint after relaxation becomes the permissible minimum.

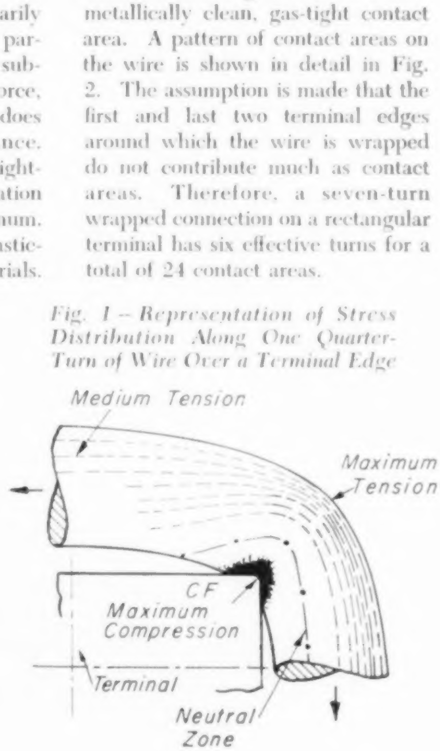
This force is related to the elasticity or elastic reserve of the materials. In a screw connection, for example, there is elastic deformation by elongation of the screw shank, bending in the screw head and compression of the threads. In most electrical connections, the wire is a soft material such as copper or aluminum, nearly always compressed beyond its yield point. Only the recovery of overstressed material can be considered as elastic reserve. Screws and terminal blocks, on the other hand, are normally of harder materials (such as nickel silver, brass or phosphor bronze) having little creep and considerable elasticity; loss of potential energy in the wire is compensated for by the energy stored in the screw or terminal.

The solderless wrapped connection is quite similar in structure and performance to the conventional screw connection, with the added advantages of lower cost and smaller size. The latter factor is particularly important in communications and electronic equipment.

As mentioned, the terminal best suited to a wrapped connection is one of rectangular section. It is inexpensive, since it can be blanked from sheet stock or coined from round wire, and becomes ideal for a pressure connection because the edges produce a concentrated high pressure on the wire. Stress distribution in the wire, resulting from pressure of the terminal edges, is sketched in Fig. 1.

If the wire is wound with high tension around the rectangular terminal, the edges dig into the soft copper wire, crush and shear the oxide, or even enamel in the case of enameled wire, on both wire and terminal, forming an intimate and metallically clean, gas-tight contact area. A pattern of contact areas on the wire is shown in detail in Fig. 2. The assumption is made that the first and last two terminal edges around which the wire is wrapped do not contribute much as contact areas. Therefore, a seven-turn wrapped connection on a rectangular terminal has six effective turns for a total of 24 contact areas.

Fig. 1 – Representation of Stress Distribution Along One Quarter-Turn of Wire Over a Terminal Edge



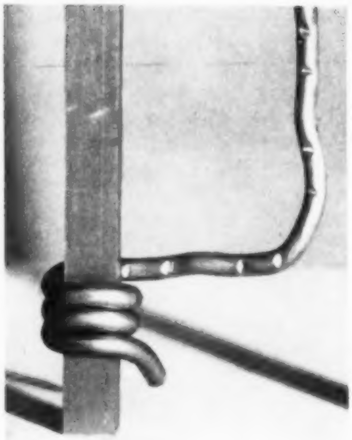


Fig. 2 – Sufficient Tension Is Applied to the Wire to Indent It at the Contact Points as Shown. Edges of the harder terminal material also are slightly deformed

When the elastic energy which holds the two surfaces together is small, various disturbances – handling, vibration, temperature changes and cold flow – may cause a partial separation of the interlocking metal particles and thus alter the resistivity. In normal telephone applications, a good connection calls for sufficient contact area and contact pressure, plus sufficient elastic reserve to maintain area and pressure throughout the desired life which, as stated, may be 40 years or more.

What about the effects of these mechanical "disturbances"? From the point of view of handling and vibration, the wrapped connection shows up well. The locking effect on the rectangular terminal prevents loosening of the center turns of the wire; in vibration tests the solderless outlasted soldered connections. Explanation for this is that with soldered joints, a sudden change in cross section from wire to solder lump localizes stresses at a small area, a condition also existing in screw connections at the point where the wire emerges from under the screw head.

When a connection is subjected to high temperatures, possibly from heavy currents or heat transfer from adjacent components, the pressure at the joint is relaxed. Under ordinary conditions the relaxation of pressure with temperature and time in a solderless wrapped joint is not sufficient to indicate any change in electrical resistance during a 40-year life. Furthermore, solid-state diffusion takes place as time progresses, strengthening the joint mechanically and improving it electrically. Tests show that stress relaxation occurs at a rate such that half the so-called "hoop" stress is relaxed in 2500 years at room temperature and in about 40 years at 135° F. However, this relaxation is offset by solid-state diffusion, an example of which is shown in the photomicrograph, Fig. 3.

It should be pointed out in passing that the contacting metals are not "cold welded" in the way that two pieces of aluminum can be joined when cold pressed together with strains in excess of 75%. Strains at the point of contact in wrapped connections do not exceed 30 to 40% and the wire may be unwrapped from the terminal freely. The twin processes of stress relaxation and self-diffusion are the controlling factors in the permanence of the joint.

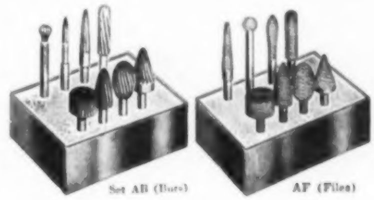
With reference to the effects of atmospheric corrosion, studies show that, where oxidation is the primary factor, the rate of corrosion of zinc varies linearly with time, while that of copper varies as the square root of the duration of exposure; the rate for brasses falls between copper and zinc. Depth of metal which will corrode during a 40-year period in a central telephone office is estimated as follows: Zinc 0.00023 in., copper 0.000105 in., and tin negligible.

Fig. 3 – Corner Section of a Heat Treated Wrapped Joint Using Bare Copper Wire on a Wire Spring Relay Terminal of Nickel Brass, Flattened and Tinned. Constituents formed by solid-state diffusion can be seen on the originally bare copper. × 250

MARTINDALE

ROTARY BURS AND FILES

Made of high-speed steel. Produced in our own factory where uniform hardness is assured by heat-treating in electric furnaces on which the temperature is closely controlled by electric eyes.



Sets AB & AF	Per Set
1 set	$11.05 net
2 to 11 sets	9.75 net
12 or more	8.45 net

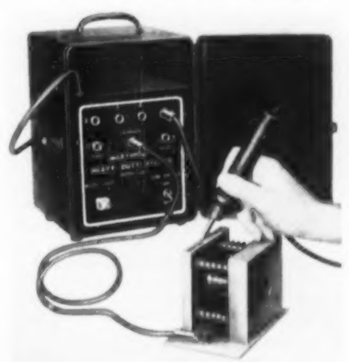
The above sets, with ¼" diameter shanks, are composed of the 8 most popular sizes for general use.

Over 200 sizes and shapes (total over 75,000 pieces) are carried in stock for immediate shipment.

DEMAGNETIZER — Model D-3

This tool quickly and easily removes magnetism from cutting tools such as cutters, drills, saws, etc., and thus keeps them free from chips and metal-slivers that reduce production. Cuts cost of tool maintenance.

HEAVY DUTY ETCHER



Model A-A has wide use as a production-line etching tool. With six heats it is effective on small parts and also on large pieces such as shovels, castings, etc. Comple e with ground lead, heavy metal case, etc.

Send for new Catalog No. 29 with 64 pages of Maintenance, Production and Safety Equipment.

MARTINDALE ELECTRIC CO.

1372 Hird Avenue, Cleveland 7, Ohio

Wrapped Wire - Terminal Joints

Thus the effects of atmospheric corrosion on terminal connections are of little moment.

When dissimilar metals are joined in a connection, there is possibility of electrolytic corrosion. However, the proximity of the metals to each other in the electromotive series which are under consideration here, and the absence of condensation, rule out possibilities of this danger.

Comparison with other pressure connections indicates how much elastic reserve a solderless wrapped joint must have to withstand the aforementioned disturbances. Thus, with a No. 4 (0.112 in.) screw the force exerted in clamping No. 24 wire is about 135 lb. Elastic energy is stored by compressing the wire and elongating the screw shank. In the wrapped joint, a total force of 90 lb. is exerted on the edges of the terminal (24 corners). Here the greater energy is stored in the terminal which receives torsional as well as compression stress from the tension in the wrapped wire. In the screw connection the stored energy is about equally divided between screw and wire. The greater energy stored in the terminal of the wrapped joint proves advantageous, since the harder terminal material has less cold flow than the copper wire.

Since the screw connection invariably depends importantly upon the human element, that is, the torque applied by the operator, the actual force exerted may vary anywhere from 75 to 150 lb. The wrapped connection, on the other hand, is made with a calibrated power tool, and can be counted on to give substantially the same contact force at all times.

To understand how wire and terminal interact when they are under mutual stress and exposed to heat, the elastic deformation of the wire and terminal must be analyzed. The wrapped wire on the four sides of the terminal rectangle is, of course, under tension. This tension causes the terminal to twist, due to the fact that the terminal is surrounded by a helix and not by hoops. The visible twist deformation of the terminal is used to determine the wire tension.

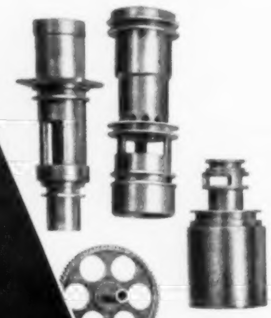
Wire tension is not directly proportional to the wrapping tension or applied force. The reason for this is that at a small applied force, the bending of the wire around the corner of the terminal produces an additional increment of tension. For example, at a terminal twist angle of 15° the wrapped tension is nearly twice the applied tension, whereas at a twist angle of 33° wire tension and wrapping tension are about equal. At higher values of applied tension, the wrapped tension increases at a much slower rate as a result of the terminal's taking a set. At 1300 g. of applied tension, which is recommended for wrapping No. 24 wire, the wrapped tension is 1210 g.

Most of the elastic energy stored in the wire is in the area marked "medium tension" in Fig. 1. Here the stress is about 8500 psi., assuming that a 20-mil wire is wrapped with 1300-g. force. Stresses at the corners are not uniform and hence not easily determined. The point of highest concentration is in the center of the contacting area. From that point to the periphery there is a pressure gradient similar to that of a circular, compressed thin film of viscous material. At the boundary

(Continued on p. 166)

BRIGHT BRAZING

OF STAINLESS STEEL AND NON-FERROUS METALS



Bright-brazed and bright-hardened parts, courtesy Hamilton Standard Division, United Aircraft Corporation.

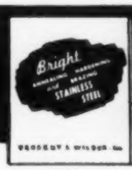
WITH A SARGEANT & WILBUR CONVEYOR FURNACE

Now, parts made of stainless can be BRIGHT-ANNEALED, BRIGHT-HARDENED or BRIGHT-BRAZED without oxidation, on a continuous production basis. They come from the controlled-atmosphere conveyor furnace scale-free, bright and clean.

No pickling, sand blasting or tumbling required. These costly operations are eliminated, so your parts retain their sharp design and edges. A special Sargeant & Wilbur alloy for bright-brazing makes the joint practically invisible because it resists dulling and matches the metal color perfectly. Steel and non-ferrous metal parts are brazed in the same operation with excellent results.

Your samples processed FREE. To see your products bright brazed, send samples and specifications.

SARGEANT & WILBUR INC.



186 Weeden Street
PAWTUCKET, R. I.

Send for free illustrated booklet giving more information on the Sargeant & Wilbur Conveyor Furnace.

Name ....

Company ....

Address ....

REPRESENTATIVES:

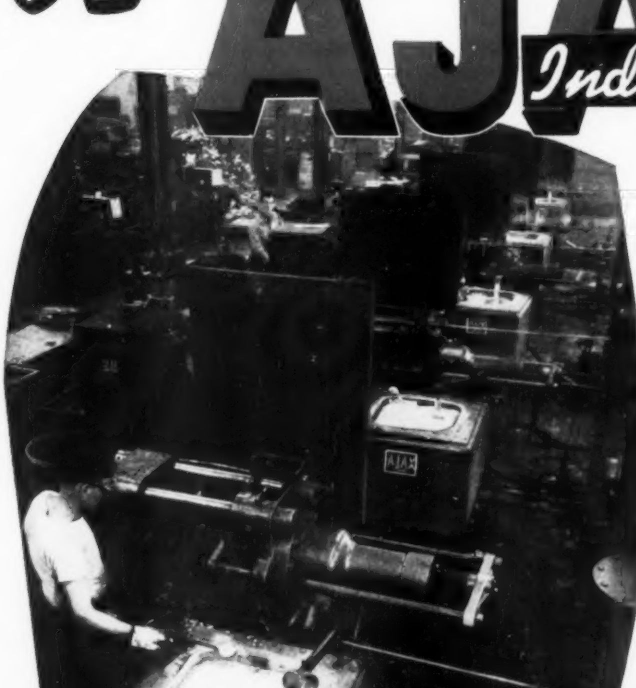
NEW YORK CITY and EASTERN PENNSYLVANIA—Gerald B. Duff, 68 Clinton Ave., Newark, N. J.; MICHIGAN—M. C. Schwer, 2970 W. Grand Blvd., Detroit 2, Mich.; OHIO, INDIANA, WEST VIRGINIA, KENTUCKY and WESTERN PENNSYLVANIA—M. L. Snodgress, 4298 Silsby Road, Cleveland 18, Ohio; NEW ENGLAND—James J. Berkis, 184 Weeden St., Pawtucket, R. I.

62

AJAX

TAMA-WYATT

Induction Furnaces–

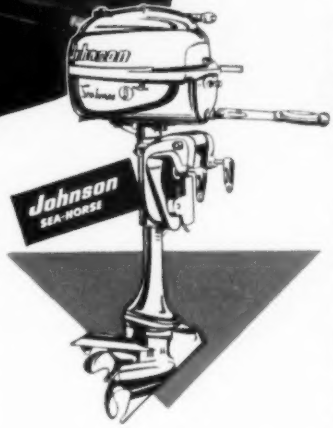


help Johnson Motors produce millions of aluminum alloy die castings per year

Photo shows a part of the Aluminum Alloy Die Casting Shop at Johnson Motors.

Johnson Motors, Division of Out-Board & Marine Mfg. Co., Waukegan, Ill., has the largest aluminum die casting plant in the world, using exclusively electric furnaces for melting and holding the metal to be processed in die casting machines for the production of outboard motors.

AJAX Induction Furnaces have proved most satisfactory for this concern because they have automatic temperature control, gentle movement of the metal (which prevents segregation), and amazingly low maintenance cost. Some furnaces have been operating for as long as 7 years without renewal of refractory lining.



"The best holding furnaces for aluminum die casting machines are considered to be electric induction furnaces. Where ingot is being added directly to the furnace for die casting, this is the only furnace on which there is little possibility of sludge formation at the bottom. The reason for that is obvious. The heat is where it belongs, down at the bottom of the furnace *in the metal.* Also, the agitation due to the internal electrical stirring, which has no effect on dross inclusions, gives the best conditions for holding furnaces (for either die casting or permanent molding), especially if it is desired to add pig directly to the furnace."

—From answer to "Quizmaster" question, provided by technical service staff of Federated Metals Div., American Smelting & Refining Co., in March 1953 issue of American Foundryman.

Write for Further Information to

AJAX ENGINEERING CORP., TRENTON 7, N. J.

AJAX TAMA-WYATT

INDUCTION MELTING FURNACE

AJAX ELECTRO METALLURGICAL CORP., and Associated Companies
AJAX ELECTROTHERMIC CORP., Ajax Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax Wyatt Induction Furnaces for Melting

Wrapped Wire - Terminal Joints

(Starts on p. 161)

line the pressure is zero. Average pressure within the contact area is about 29,000 psi., although maximum stress in the center may be as high as 100,000 psi. Stress relaxation taking place after eight days at room temperature is assumed to be due to the high initial stress in the center of the contact area seeking equalization.

In summary, it may be stated that in the portion of the wire where most elastic energy resides, the stress after eight days is about 8500 psi. and at the points of contact 29,000 psi. After 40 years these stresses will have dropped to about 4000 and 13,500 psi., respectively, or to 47% of the original values. Creep curves of annealed copper for various stresses reveal that a stress of 8350 psi. reaches a creep value of about 0.07% in three years and, for all practical purposes, from then on ceases to creep.

The solderless wrapped connection was the outgrowth of intensive efforts to devise a better method for wiring a new general-purpose relay for telephone switching systems, the production schedule on which required something like 50 million connections a year on relay terminals alone. First result was the perfection of a tool which would wrap a few turns of wire around the terminals of a relay and do it efficiently on closely spaced terminals.

Western Electric Co., the Bell System's manufacturing subsidiary, then discovered the tools could be used to advantage on existing types of terminals on other equipment, and is now making extensive use of them. These connections, of course, involve no particular tension on the wires and are soldered after wrapping. Elimination of soldering was the logical next step, but it called for a new kind of tool to produce the high tension on the wire while being wrapped onto the terminal.

It is common practice in the manufacture of helical springs to anchor the end of the wire in a hole in an arbor and tension the wire with a friction pad. Rotation of the arbor forms the helical spring. To adapt this idea to closely spaced electrical terminals is impractical, since the wire cannot be fed tangentially to the terminal and the latter cannot be rotated. So, a variation was worked out, whereby a rotating spindle houses a stationary terminal in an axial opening in the spindle, and is provided with a second opening radially separated from the axial opening and arranged to accommodate the "skinned" end of the wire to be attached. When the spindle is rotated, the wire is formed into a spiral about the stationary terminal.

Anchoring the wire end in the second opening and feeding it tangentially to the terminal as the spindle is rotated has inherent limitations in working with closely nested terminals. To overcome them, an improved method was devised to permit axial feed of the wire. The operation of loading the wire and wrapping the connection can be explained best by reference to Fig. 4 which traces the successive steps in

(Continued on p. 168)

PYRASTEEL Alloy Steel PARTS for producing a lasting finish

Permanently BRIGHT

PYRASTEEL Operating Handle used on a food vending machine.

The manufacturer tried a number of materials, but the handle would soon become discolored from use.

Then PYRASTEEL was employed for casting these units—result: the highly polished surface remains impervious to stain or wear under all conditions of service.

Write for PYRASTEEL Bulletin

Permanently SANITARY

PYRASTEEL Stainless Parts are essential in many applications for modern food processing equipment.

CHICAGO STEEL FOUNDRY COMPANY

Kedzie Avenue and 37th Street, Chicago 32, Ill.

• Makers of Alloy Steel for Over 45 Years

NORTH AMERICAN

COMBUSTION EQUIPMENT PUTS HEAT TO WORK IN

The World's Most Modern Foundry

Weld Preheat and Stress Relieve Furnaces
Cleveland Foundry

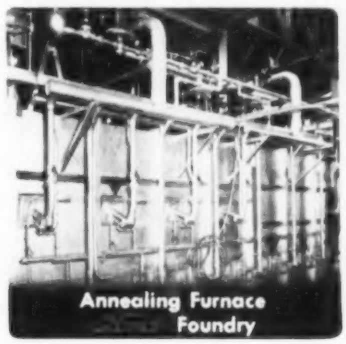
One of 3 identical recirculating furnaces built by R-S Products Corp. Engine blocks and heads are preheated for welding in the 3 zones on the right conveyor and stress relieved in 3 zones on the left. Each zone is heated by a NA* sealed-in tunnel gas burner with a NA* aspirator mixer, atmospheric regulator, and pilot.

Forehearth Preheater
Foundry

One of ten forehearths built by Modern Equipment Co. and preheated with NA* flame retention gas burners. A remote control handle actuates an air control valve and an aspirator mixer and regulator proportion the gas to the air.

Annealing Furnaces
Cleveland Foundry

Four completely conveyorized Hagan direct-fired furnaces for annealing manifolds and small parts. The fuel is natural gas maintained at zero pressure by NA* regulators. Three NA* turboblowers on each furnace supply 1300 cfm of 16 osi air to the 3 heating zones and 3800 cfh of 8 osi air to the air cooling zones.



Annealing Furnace
Foundry

A close-up view of the firing zone of one of the annealing furnaces shown at the left. 26 NA* aspirator burners with NA* pilots are arranged in 3 zones and controlled by NA* air motors and adjustable port valves.

*NORTH AMERICAN—the name that stands for reliable industrial combustion equipment for gas, oil, and dual-fuel. TELL YOUR FURNACE BUILDER that you want North American's experience and scientific know-how built into your next job.

The NORTH AMERICAN
Manufacturing Company
4455 East 71st St. • Cleveland 5, Ohio

Wrapped Joints

(Starts on p. 161)

the process. A more detailed drawing of the tool tip, Fig. 5 (p. 170), discloses exactly how the skinner wire is anchored between the stationary sleeve and rotating spindle.

The tool or "gun" itself, shown in use in Fig. 6, may be either electric or air powered, both of which are trigger actuated.* Tension in the wire is produced by rotating the spindle around the terminal, thereby pulling the short skinner wire out of the feed slot and wrapping it around the terminal bar. In this process, each increment of skinner wire length undergoes several bending operations.

The first operation occurs at the edge of the feed slot where the wire is bent through an angle of less than 90°. The second is the straightening-out of the bent wire. The third takes place as the wire is wrapped around the terminal. All three contribute to the tension with which the wire is wrapped.

Bending forces are inversely proportional to the respective bending curvatures, and frictional forces in

(Continued on p. 170)

*According to a report in the *Wall Street Journal*, the Western Electric Co. is making the wrapping tool available to industry generally through licensed portable tool manufacturers. One is the Keller Tool Co. which, through its Wire-Wrap Division, Grand Haven, Mich., has been producing the wrapping gun since the first of the year.

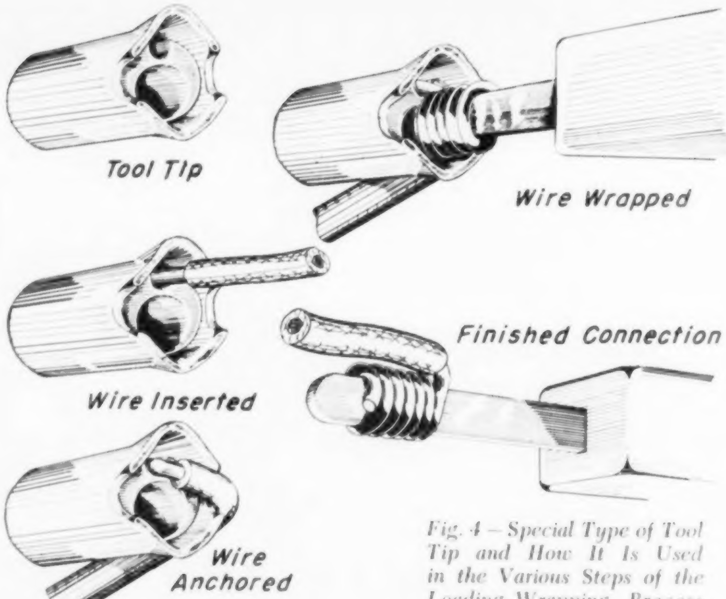
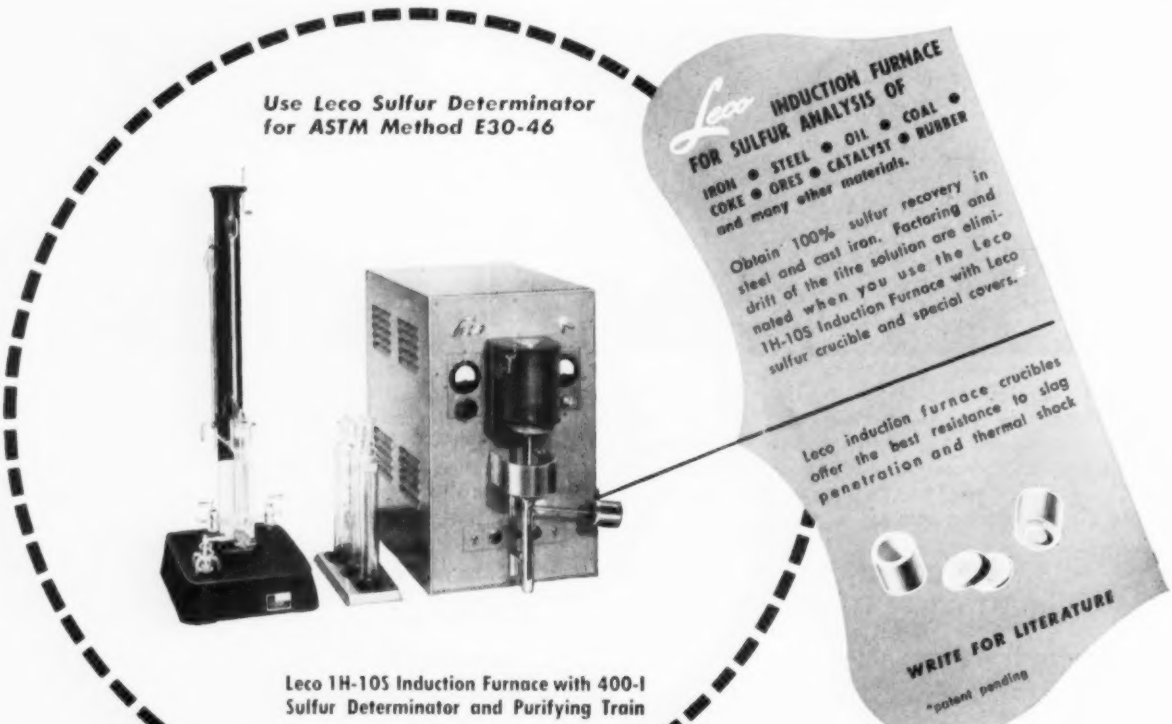


Fig. 4 – Special Type of Tool Tip and How It Is Used in the Various Steps of the Loading-Wrapping Process



dedicated to flamatic progress

in selective surface hardening

A Section of the Flamatic Chemical and Metallurgical Laboratory

Frederick V. Geier, President, in formally dedicating the new **Flamatic Heat Engineering Building,** emphasized the long-range importance of this latest advance in the continuing progress of Flamatic Selective Surface Hardening.

Many activities will be carried on in this spacious new building . . . long range heat engineering and development work, special burner and tooling projects, experimental tests on customer's parts, final run-off and inspection of completed Flamatics. A complete chemical and metallurgical laboratory and a fully equipped machine shop are also provided.

This major investment in Flamatic progress combined with the skills of an experienced sales and engineering staff, and the use of modern manufacturing facilities, can yield important dividends for you in terms of better parts, at lower cost. Investigate Flamatic application to your surface hardening operations.

flamatic

THE CINCINNATI MILLING MACHINE CO.

Cincinnati 9, Ohio, U.S.A. • CINCINNATI

Wrapped Joints

(*Starts on p. 161*)

turn are proportional to the bending forces. Tension imparted to the wire as it is wrapped, however, is due not only to the friction forces alone but also to the combined effect of friction and bending effort. If the wire were completely elastic and friction zero, no tension could be produced; but there would be tension if the friction were zero and the wire only partly elastic as in the case of copper. Likewise, there would be tension if a completely elastic wire were pulled around an edge having friction.

Trend to smaller circuit components is marked in all branches of communication engineering. With a tool tip as small as the one shown in Fig. 6, it is possible to wire apparatus having terminals spaced as closely as $2\frac{1}{2}$ times the width of the terminals. An example is the terminal block shown in Fig. 7 which measures $1\frac{1}{8} \times \frac{3}{4} \times \frac{9}{16}$ in. and accommodates 44 terminals. Here, a total of 48 No. 26 (0.0159-in. diameter) wires are wrapped on the terminals; however, each terminal will handle as many as three wires, or a possible total of 132 connections in an area of less than 1 sq.in.

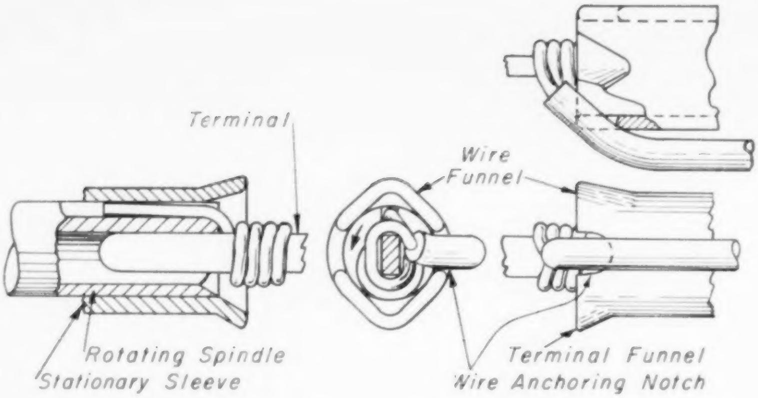


Fig. 5 – Sketches Showing Method of Wrapping the Skinner Wire on a Rectangular Terminal

When terminals are not closely spaced, it is unnecessary to use the anchoring notch in the tool sleeve. The insulated portion of the wire can be held by some external means at an angle of about 90° to the tool spindle. High acceleration of the wrapping motor induces a mass reaction of the wire leading to the terminal. This counterforce, coupled with a slight tension on the supply wire, is enough to insure wrapping the first turn. No further anchor is needed, as the first turn locks the wire to the terminal.

Removal of the solderless wrapped connection is simple, either by stripping or by unwrapping. Pliers or special stripping tools which slide over the terminal to bear against the inner end of the wrap are used for disassembly. Stripping force naturally varies with the tightness of the wrapping but is not excessive. Little damage is done to the terminal by stripping, although it is not recommended that the stripped wire be reused. It can be snipped off, reskinned and rewrapped or, if not long enough, one or two turns may be wrapped and then soldered.

There appears to be no upper limit to the size of wire wrapped on adequately proportioned terminals.

(*Continued on p. 172*)

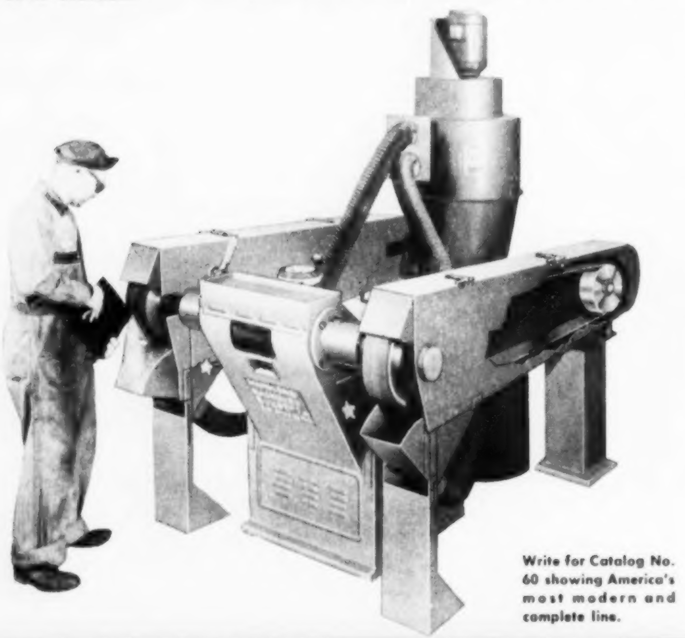
Hammond OF KALAMAZOO
GOOD MACHINERY SINCE '82

MODERN Self Contained GRINDER-POLISHER

Hammond Variable Speed (1500 to 3000 RPM) Polishing and Buffing Lathe. Models up to 50 HP available.

Hammond Cyclone Dusko-lector. One of a wide line of Cyclone and Filter Types.

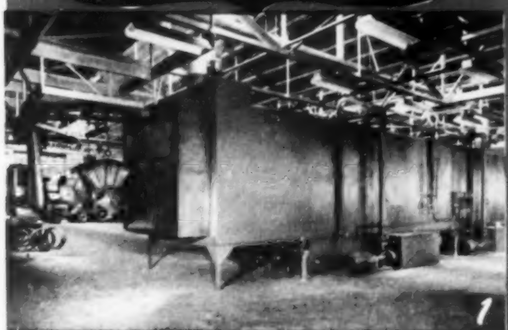
Hammond Backstands. 10 Air and Spring Tension Models to choose from.

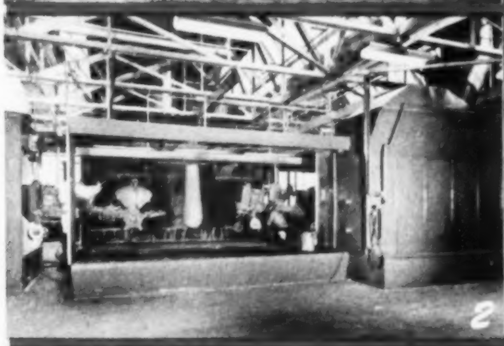


Write for Catalog No. 60 showing America's most modern and complete line.

Hammond Machinery Builders INC.
1647 DOUGLAS AVENUE • KALAMAZOO, MICHIGAN

DESPATCH





A FINISHED TRACTOR *every 5 minutes!*

Tractor finishing at the J. I. Case tractor plant, Rock Island, Ill., has been doubled and quality of finish raised to a new high with this modern finishing system designed, built and installed by Despatch. Housed in a new, well lighted building the system is giving Case tractors a rich, durable baked on finish in the familiar Case Flambeau Red. The operation includes washing, painting and finish baking accomplished as the tractors move on a 600-ft. continuous monorail conveyor. It's all done in a fraction of the time formerly required on another system, and at reduced labor and material costs.

1 After loading the conveyor enters 3-stage washer where tractor gets a 160° F. phosphate wash, cold water mist bath, and 180° F. hot water rinse.

2 Tractors are spray painted as they move through staggered water wash spray booths, each 20 feet long. Paint is heated to 170° F. —eliminates need for thinner and allows closer spraying to cut down overspray. Each unit receives one coat which represents 2 gallons of paint.

3 A lasting, weather resistant finish is baked on at a temperature of 225° F. in this 96-ft. oven heated by steam from the Case central steam plant. As the tractor emerges from the oven, tires coming to the area via another conveyor line are mounted, and other parts are added to complete the unit. Tractors are taken off the conveyor in the unload zone at the extreme left and driven away under their own power.

LET DESPATCH MODERNIZE YOUR FINISHING OPERATIONS

Now is the time to replace your obsolete finishing system with a modern Despatch system. Increased production, higher quality and lower costs will result. Despatch engineers are ready to analyze your problem and plan a system best suited to fit your particular needs.

Write, wire or call Dept. P today for further details.

DESPATCH OVEN COMPANY

MINNEAPOLIS OFFICE: 619 S. E. 8th Street

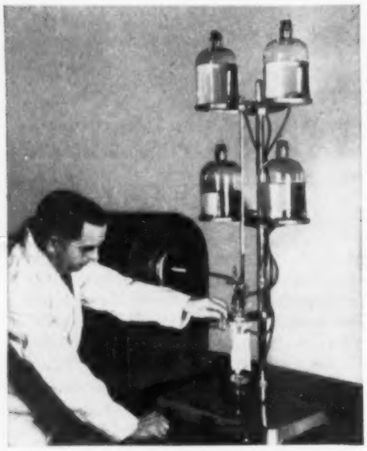
CHICAGO OFFICE: 4554 N. Broadway

Sales Offices in all Principal Cities

PRACTICAL SULFUR ANALYSIS

Accurate Results in 3 MINUTES with the

DIETERT-DETROIT SULFUR DETERMINATOR



No. 3104 Three Minute Sulfur Determinator

The Dietert-Detroit Sulfur Determinator used with the Varitemp or Hitemp Combustion Furnace provides the most practical means of getting results in a few minutes with accuracy equal to or better than any other method.

APPLICATIONS	FEATURES
Metals and Ores	Lowest First Cost
Fuel Oil and Lubricants	Simple Operation
Solid Fuels and Greases	Exact End Point
Rubber and Plastics	Visible Reagents
Inorganic Sulfates	Efficient Bubbler
Organic Chemicals	Meets A.S.T.M. Spec.

Let our chemists suggest a complete ready-to-go set-up to solve your sulfur analysis problems.

CONTROL EQUIPMENT
HARRY W. DIETERT COMPANY
9330 ROSELAWN • DETROIT 4, MICH.

Wrapped Wire-Terminal Joints

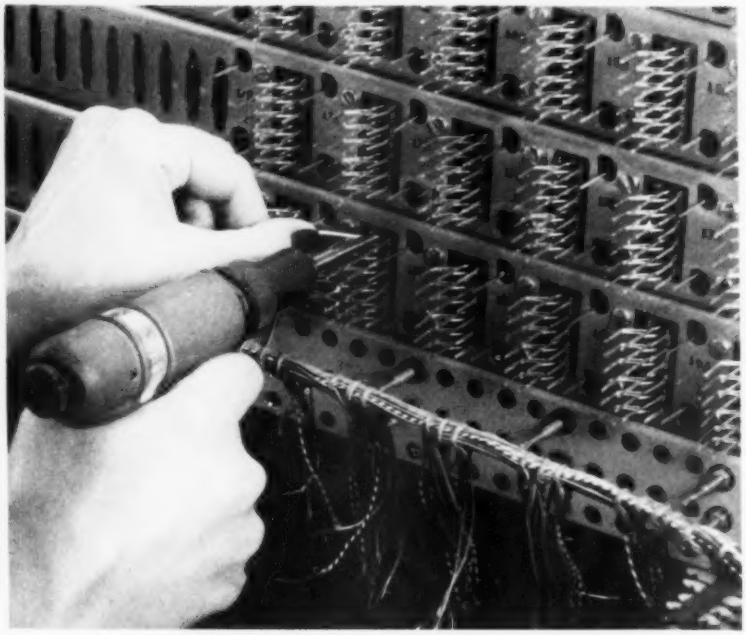


Fig. 6 – Air-Powered Wrapping Tool Here Is in Use Making Solderless Connections of Wires to Terminal Board for Telephone Central Office. Note the close quarters into which the tool spindle must fit

(Starts on p. 161)

Satisfactory connections have been made with both aluminum and copper wire over 200 mils in diameter. Torque necessary to wrap large diameters increases rapidly – with the third power of the diameter. Wires as fine as No. 39 (0.0035 in. diameter) likewise can be handled, with a slight change in design of the wrapping tool to facilitate anchoring the finer wire.

Terminals of other than rectangular cross section lend themselves to solderless wrapping, the only essential being one or more contacting edges substantially crosswise to the wire axis. Preferred shape is a U or V, to avoid excessive twisting

(Continued on p. 174)

Fig. 7 – A 44-Point Terminal Block With Capacity of 132 Connecting Wires. Only 48 wires are used here, all No. 26 (0.0159 in. diameter). Space occupied by the entire assembly is only 0.5 cu.in.

Specify

N·A·X
HIGH-TENSILE STEEL

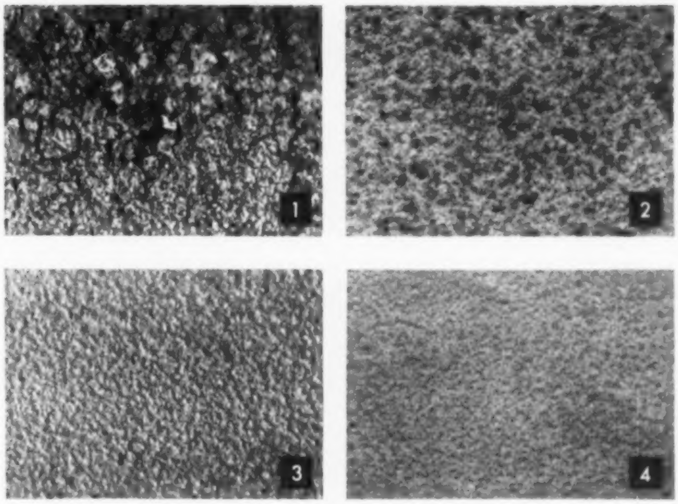
for

Longer Life

through

Corrosion

Resistance



Photographs show effects of atmospheric corrosion after six years' exposure of unprotected surfaces.

1. Low carbon sheet steel showing friable heavy rust.
2. Low carbon sheet steel with rust removed showing heavy pitting.
3. N-A-X HIGH-TENSILE sheet steel showing tightly adhering rust.
4. N-A-X HIGH-TENSILE sheet steel with rust removed showing absence of excessive pitting.

Low carbon sheet steel lost four times more weight than N-A-X HIGH-TENSILE in six-year test. With increased time this ratio becomes greater.

N-A-X HIGH-TENSILE, having 50% greater strength than mild carbon steel, permits the use of thinner sections—resulting in lighter weight of products. It is a low-alloy steel—possessing much greater resistance to corrosion than mild carbon steel, with either painted or unpainted surfaces. Combined with this characteristic, it has high fatigue and toughness values at normal and sub-zero temperatures and the abrasion resistance of a medium high carbon steel—resulting in longer life of products.

N-A-X HIGH-TENSILE, with its higher physical properties, can be readily formed into the most difficult stamped shapes, and its response to welding, by any method, is excellent.

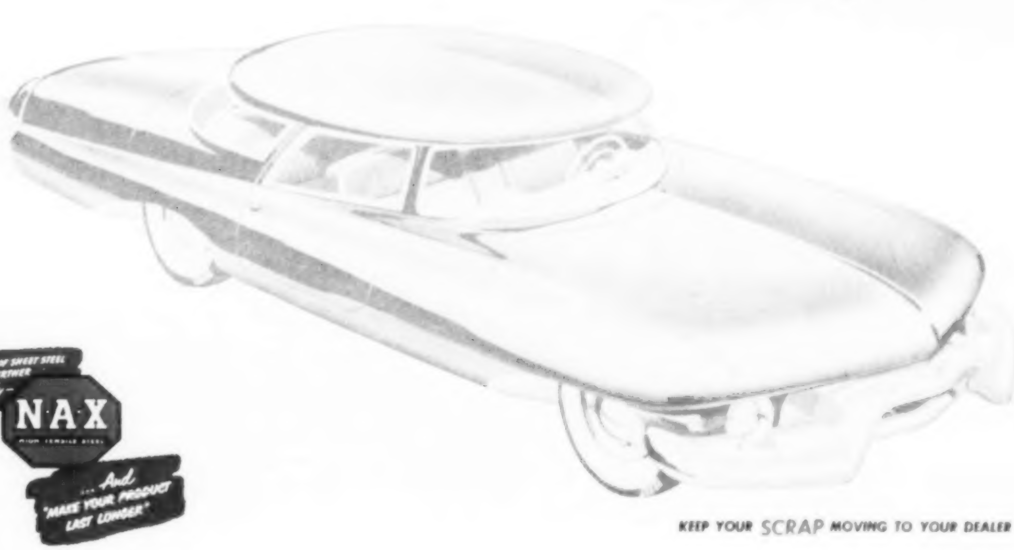
Due to its inherently fine grain and higher hardness, it can be ground and polished to a high degree of lustre at lower cost than can mild carbon steel.

Your product can be made lighter in weight . . . to last longer . . . and in some cases be manufactured more economically, when made of N-A-X HIGH-TENSILE steel.

GREAT LAKES STEEL CORPORATION

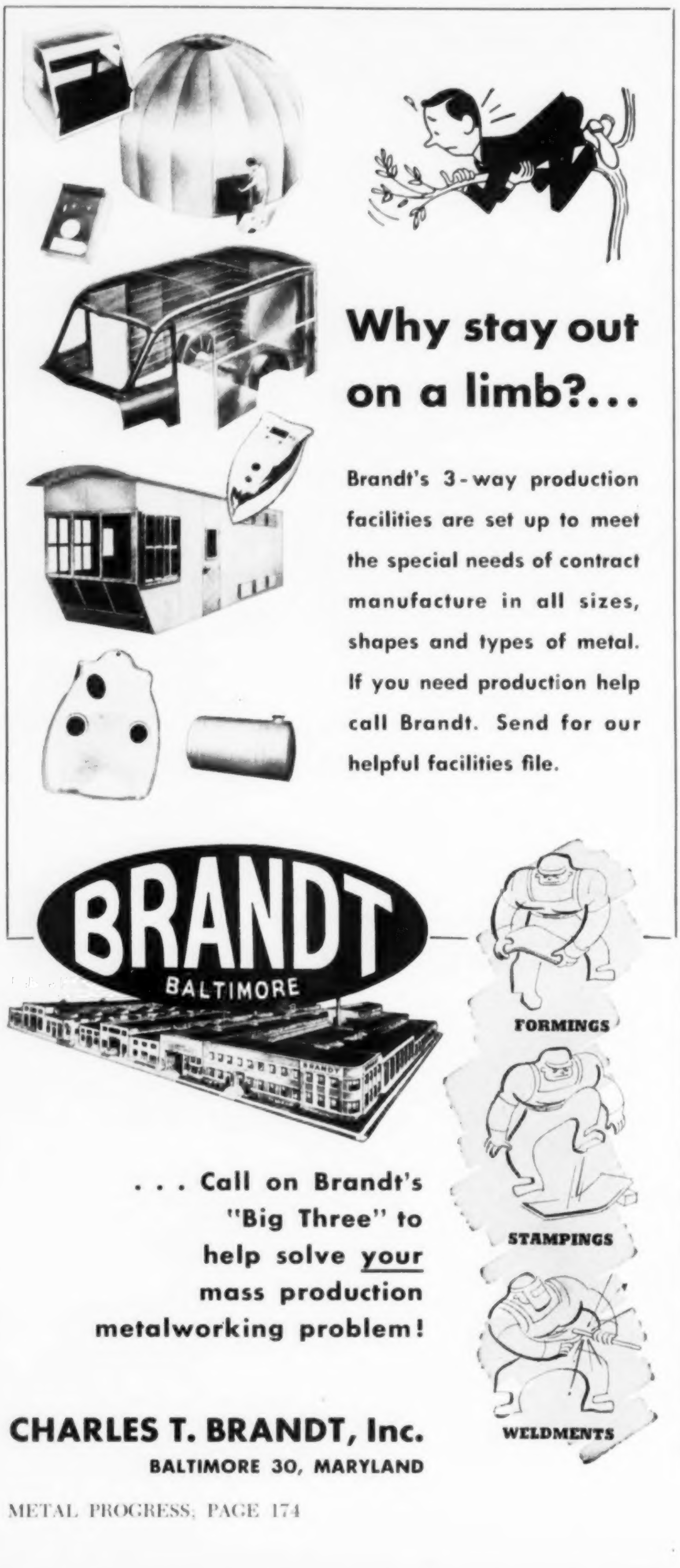
N-A-X Alloy Division — Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION



MAKE A TON OF SHEET STEEL GO FARTHER
Specify—N·A·X HIGH TENSILE STEEL
...And "MAKE YOUR PRODUCT LAST LONGER"

KEEP YOUR SCRAP MOVING TO YOUR DEALER



Wrapped Joints

(Starts on p. 161)

during wrapping. Such terminals are particularly suited for vacuum tube sockets and thin relay springs. Stranded wire connections also have been made to terminals by a system using a serrated terminal and separate solid binding wire. An alternative method is to tin the skinned end of a stranded wire (in effect, form a "solid" section) and then wrap it the same as a solid wire.

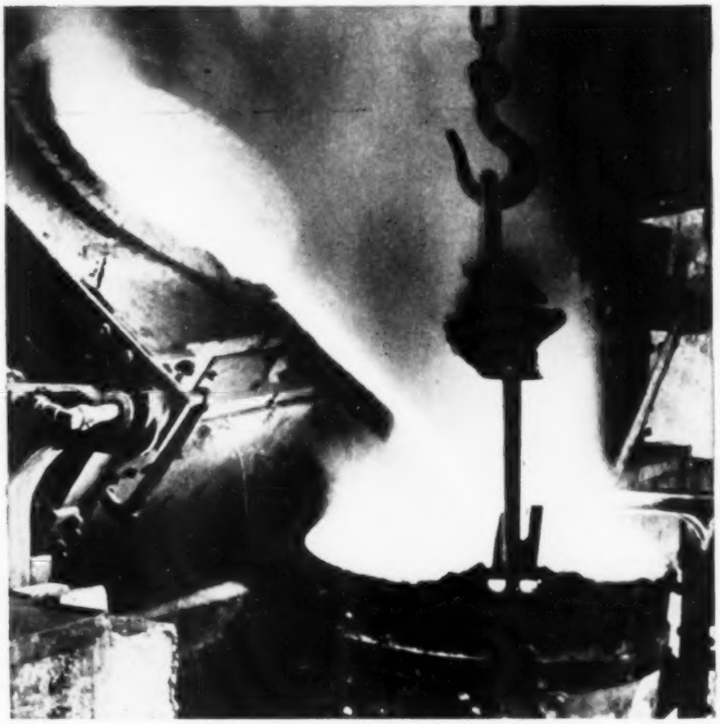
Other types of tools capable of cutting, skinning and wrapping the wire in one operation are now under development, concurrent with studies of problems presented in adapting the basic techniques to other conductors like aluminum. What amounts to an entirely new area of engineering effort has been thrown open, possibly to include at some future date a completely automatic wiring machine.

SUMMARY

Making electrical wire-terminal connections by wrapping copper wire under tension onto a rectangular terminal bar, by means of a calibrated power tool, dispenses with the need for solder in the joint. The method has been demonstrated as entirely practical and productive of joints with proved resistivity characteristics and service life equivalent to 40 years or more. Such connections also show less breakage due to handling and vibration, more compactness, lower cost and easy disconnection, when compared with conventional types, both soldered and pressure.

Wrapped connections are sufficiently intimate to permit solid-state diffusion, but strains are not high enough for cold welding. Stress relaxation and self-diffusion occur in such a way as to leave the resistivity unchanged with time and also to maintain or even increase the strength of the joint.

Success attending the development of the solderless wrapped connection of copper wire to brass, nickel silver, phosphor bronze or steel terminal strips, along with the practical application of the method and design of the tools to do the work, suggests a broad field of future usefulness.



50 TONS

of Stainless Steel a Day...

Melted in this AJAX-NORTHRUP INDUCTION FURNACE

Every 1¾ hours, one of these Ajax-Northrup furnaces pours 10,000 pounds of top-quality stainless steel. Total capacity is well over 50 tons a day!

Composition is uniformly exact. Alloying elements are controlled within a fraction of a per cent in every melt. Carbon is consistently kept below 0.05%.

Losses of expensive elements are negligible. Operating costs have been low enough to pay for the furnaces in just a few years!

This installation is typical of the growing use of induction melting for larger and larger jobs. In some of these, induction melting is the only way the job can be done. In others, it does the job better, faster, and at lower cost than any other melting method.

No matter what the job . . . or the quantity . . . Ajax-Northrup's 36 years of induction experience can help you. Just write or call us.

AJAX ELECTROTHERMIC CORPORATION
Ajax Park, Trenton 5, New Jersey

Associated Companies
AJAX ELECTROMETALLURGICAL CORP.
AJAX ELECTRIC FURNACE CORPORATION
AJAX ELECTRIC COMPANY, INC.
AJAX ENGINEERING CORPORATION

AJAX NORTHRUP

INDUCTION HEATING AND MELTING

Since 1916

148

Blowing Basic Pig Iron

(Continued from p. 144)

lar data in the paper give detailed results of these tests.

Experimental Results – The time needed to complete a blow in this converter is inversely proportional to the oxygen pressure at the tuyere. Heats cooled with steel scrap had from 0.5 to 1.0% P at the end of the carbon oxidation, whereas the heats cooled with ore were completely dephosphorized *before* the drop of the carbon flame. Thus, the use of ore additions resulted in a saving of 30 to 50% in blowing time, and needed only $\frac{2}{3}$ as much oxygen as the scrap-cooled heats. It was also found that the maximum cold scrap addition was 975 lb. per heat (18.5%), while that of iron ore was 287 lb. per heat (5.4%) in order to have a satisfactory teeming temperature at the end of the blow.

So as to obtain effective phosphorus removal before or at the end of the decarburization period, at least 220 lb. of iron ore was needed for each blow if the original phosphorus content of pig iron was 2.0%. This result shows that the iron ore provides the oxygen for the oxidation of phosphorus, FeO for the slag, and also acts strongly in reducing the temperature. Since the bath is in a violent state of agitation during the carbon boil, the iron ore acts vigorously in oxidizing phosphorus under these conditions.

The heats that were made without ore additions were much more difficult to dephosphorize, requiring a much longer blowing time and oxygen pressures as high as 12 atmospheres (176 psi.).

Nitrogen Content – The first 16 heats were made in a converter with a wide throat and the final nitrogen contents varied from 0.008 to 0.012%. Gas analyses indicated that air was being aspirated into the vessel by a high-pressure jet of oxygen. The converter was then rebuilt with a much narrower throat to overcome this, and the nitrogen in the final steel dropped to 0.003 to 0.008%. The nitrogen pickup occurred after decarburization and this effect makes the iron ore additions even more desirable. The ore-cooled heats showed an average nitrogen content of 0.0035%, whereas the scrap-cooled heats had 0.0045%. The average composition of the pig iron was about 3.70% C, 0.40% Si, 1.00% Mn, 2.00% P, 0.060% S and 0.006% N. There was considerable decrease in sulphur down to about 0.04% in the ore-cooled heats.

Slags – The slags produced in this process are mainly composed of calcium ferrite and calcium phosphate. A nominal composition is 40 to 46% CaO, 10 to 20% FeO, 18 to 20% P_2O_5, 6 to 9% SiO_2, and 3 to 5% MnO. One of the reasons that the ore addition is so useful in eliminating phosphorus from the bath is that it gives an earlier formation of the low-melting calcium ferrite, and the cooler bath – caused by the ore addition – promotes the oxidation of phosphorus in preference to carbon.

CONCLUSIONS

The results obtained from 100 heats in a small 3-ton converter, blown from the top with 98% oxygen, indicate that steels equal to openhearth steels may be produced from pig irons containing 2% phosphorus. To accomplish this the oxygen pressure, ore additions and temperature must be very carefully controlled. *(Continued on p. 178)*

Hardness testing made *Easy!*

Save Time!
Test Accurately!

Ames PORTABLE
HARDNESS TESTERS

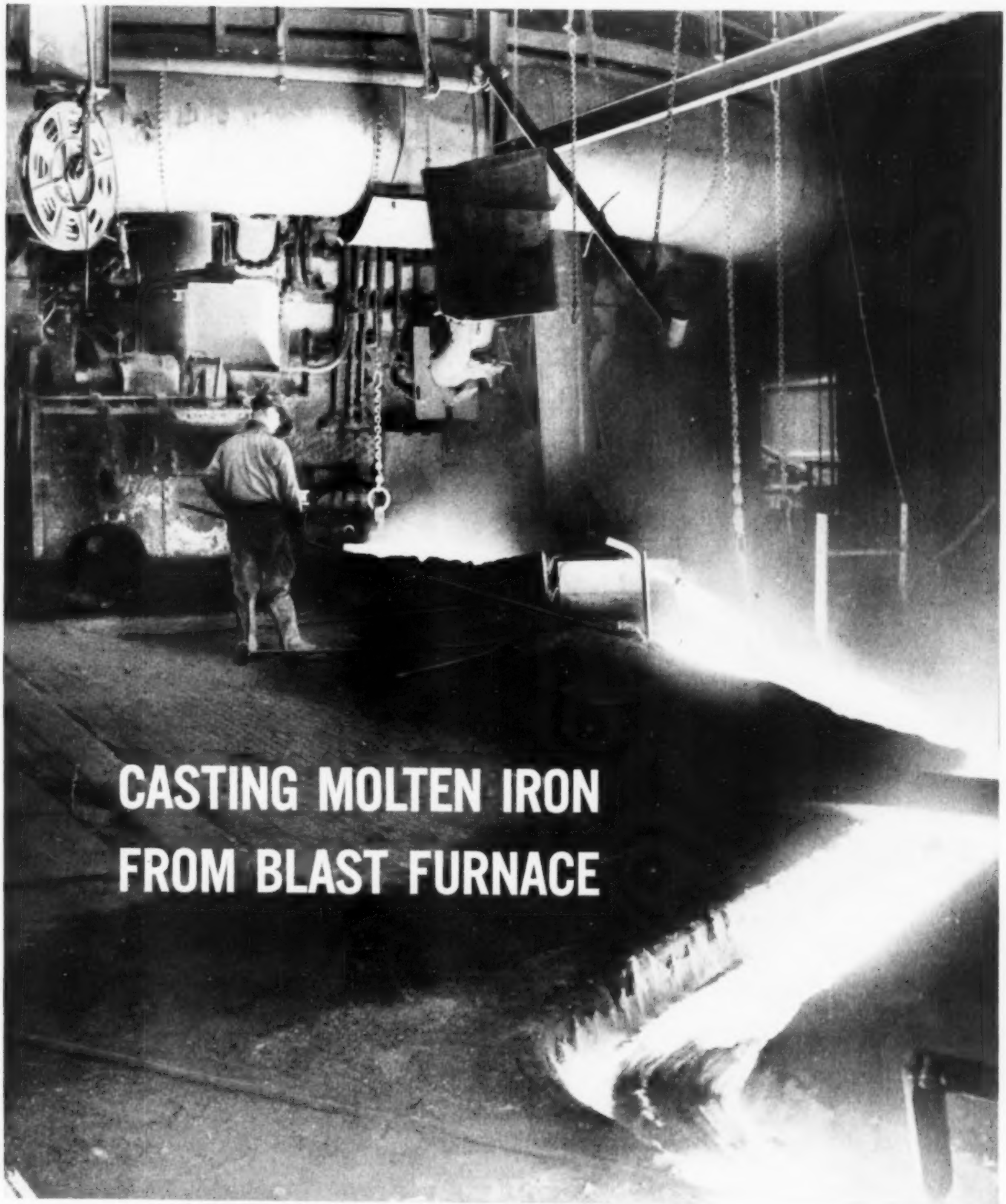
Frequent hardness testing of metals before and during fabrication and after heat treating is essential today for best results.

Ames Portable Hardness Testers answer the need for a light weight, accurate, dependable tester that may be carried to the work for on-the-job testing. They are easy to use, require no skill, and get speedy, accurate tests wherever the work may be—no delays, no cutting off specimens—no waiting for laboratory tests.

Besides testing flats, rounds, tubing, etc. Ames Hardness Testers make tests that otherwise would be impossible, such as large gears, knives, saws, blades, struts, frames and assembled parts. Thousands are in use paying for themselves over and over again in time and materials saved.

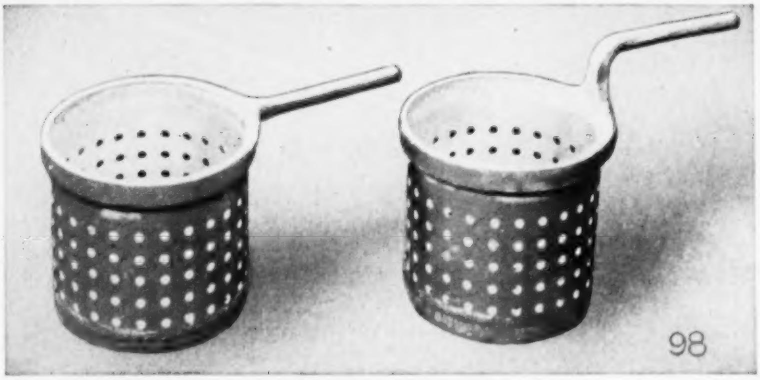
Send for literature or ask for demonstration in your plant. No obligation.

AMES PRECISION MACHINE WORKS
Makers of Ames Precision Lathes and Bench Millers
Waltham 54, Massachusetts



WISCONSIN STEEL COMPANY

AFFILIATE OF INTERNATIONAL HARVESTER COMPANY | INTERNATIONAL HARVESTER | 180 NORTH MICHIGAN AVENUE, CHICAGO 1, ILLINOIS



Salt Bath DIPPING BASKETS *from Stock!*

Don't carry an expensive inventory of special baskets when one of the stock sizes listed below will fill your needs.

Straight or offset handles—3/8" diameter perforations on 1" centers—Dependable Heat Resisting Alloy.

Following sizes ready for immediate shipment

Diameter	6"	6"	7"	7"	8"	8"
Depth	6"	8"	7"	8"	8"	12"

ALLOY ENGINEERED FABRICATION

MISCO FABRICATORS, INC.

Designers, Builders, Fabricators of Heat Resisting Alloy and Stainless Steel Equipment

1999 GUOIN STREET • DETROIT 7, MICHIGAN

TELEPHONE LORAIN 7-1545

Blowing Basic Pig Iron

(Continued from p. 176)

The blowing time depends entirely on oxygen pressure (this was varied from 7 to 20 atmospheres). Blows cooled with scrap behaved very much like air bottom-blown heats in a standard converter and required an after-blow to get complete phosphorus removal. The dephosphorization is slightly more advanced with the top-blow oxygen practice.

The most important observation is that additions of ore instead of scrap have great metallurgical advantages with respect to the final nitrogen and phosphorus content, and also lead to significant savings in blowing time and oxygen consumption. This is due to the greater cooling effect of ore as compared to scrap and to the early formation of a slag which is high in calcium ferrite.

The nitrogen content of the bath decreases during the decarburizing stage, but increases after the carbon flame drops. Apparently the suction of air into the converter causes this nitrogen pickup in the bath during the after-blow stage which is required for phosphorus removal in the scrap-cooled heats.

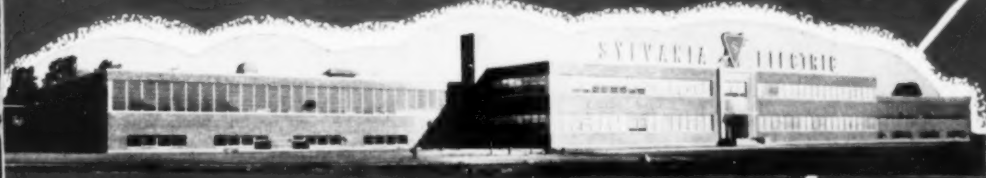
(REVIEWER'S NOTE: This conclusion conflicts with American papers on this subject, wherein it has been reported that steels containing less than 0.004% N_2 have been produced in acid-lined vessels by side blowing with air.)

The relation between the phosphorus and manganese content of the steel and the FeO content of the slag at the end of complete decarburization is pointed out. The oxygen content of the ore-cooled and oxygen-blown steel is about the same for openhearth steel of the same carbon content and temperature.

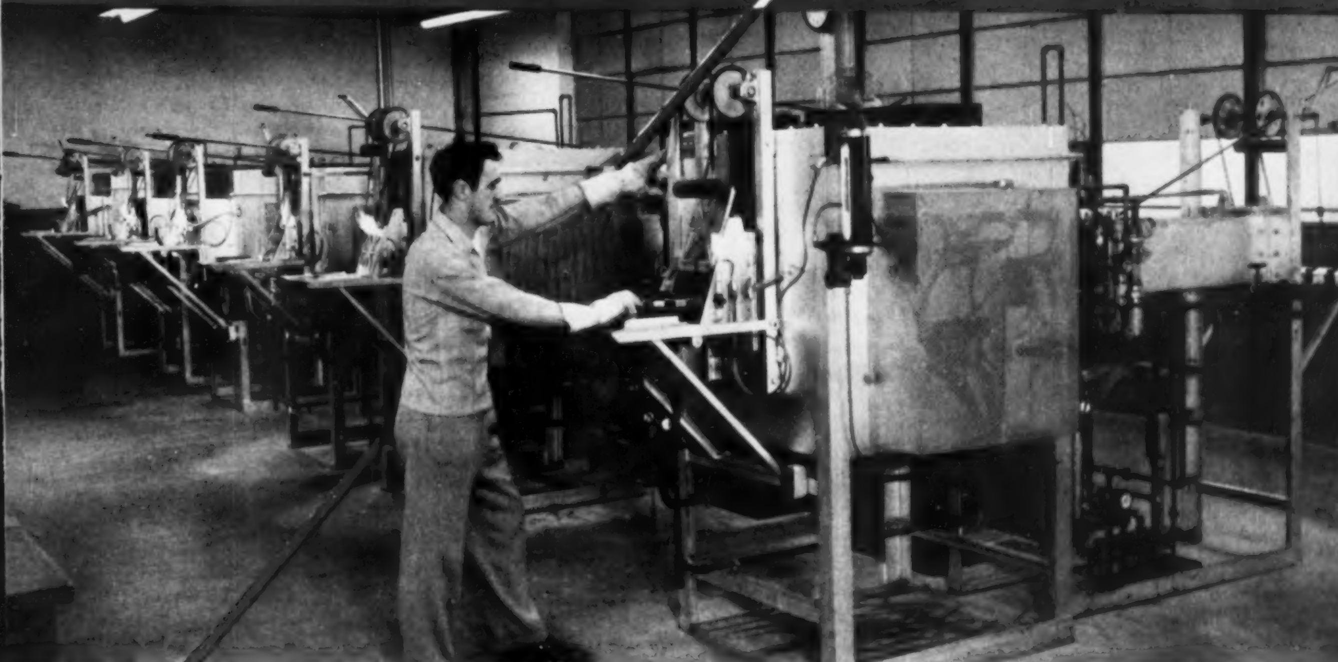
The process described might be called the oxygen-blown pig iron ore-converter process. The method can be applied to the blowing of pig iron of high and low phosphorus content to make steels equal in quality to basic openhearth steels. Comparative costs for normal basic bessemer heats, pig-iron ore and duplex openhearth heats, and the oxygen top-blown and ore-cooled converter heats show that the top blowing practice is both economically and technically competitive with the former.

E. C. WRIGHT

Sylvania's Electronics Division employs Hayes Furnaces for critical processes



Magnificent new Sylvania plant at Woburn, Mass.



Utmost cleanliness and precision of operation characterize this Hayes installation at Sylvania, Woburn.

In Sylvania plants from Massachusetts to California, Hayes controlled-atmosphere furnaces yield top quality work on a volume production basis in such critical operations as

—radar microwave TR and ATR tubes: soldering and degassifying.
—magnetron tube sub-assemblies: soldering and degassifying.
—germanium: processing GeO_2 to reduce to purified germanium.
—klystron and rocket tubes, pencil tubes: soldering and degassifying.

• • • For YOUR heat treating, enjoy the BEST in controlled atmosphere equipment —plus Hayes know-how and interested engineering assistance that assure lasting satisfaction.

CALL OUR NEAREST REPRESENTATIVE — REQUEST LATEST CATALOG

C. I. HAYES INC. 76 BAKER ST., PROVIDENCE, R. I.

Manufacturers of Electric Furnaces Since 1905

ELECTRIC CERTAIN CURTAIN FURNACES

R. O. HESS, Room 711, 26 Journal Sq., Jersey City, New Jersey
E. F. BURKE AGENCY, Room 606, 1900 Euclid Ave., Cleveland 15, Ohio
W. G. PIPER, Chicago, Ill.
JOHN F. FISHER CO., Pittsburgh, Pa.
C. A. HOOKER, 202 Forest Ave., Royal Oak, Mich.
DOLAN INDUSTRIAL SALES, 2506 Lawndale Ave., Houston 23, Texas
L. WAGNER, 112 Loomer Avenue, San Jose 12, Calif.
L. J. EDWARDS, 76 Baker Street, Providence, R. I.
T. C. GARRETT, Denver 15, Colorado
C. F. HOLMES, Birmingham, Ala.
Ardmore, Pa.

The Melting of Chill-Cast Tin Bronzes*

THE PRACTICAL foundryman will do well to heed the many warnings given in this treatise – for instance, that the phosphorizing agent should be added either in whole or in part before other alloying additions. Also, it is better to add constituents such as tin, lead or zinc after the metal has been removed from the furnace and has cooled almost to its pouring temperature. The authors have found that phosphorus in a 2% phosphor bronze heated to 2372° F., or 15% phosphor copper heated to 2012° F., is not volatilized to any appreciable extent. Oxidation, on the other hand, is an active reducer of the phosphorus content of an alloy. The presence of silicon in a leaded bronze causes loss of lead because of formation of lead silicate.

Metal losses are affected by the type of furnace used, these losses decreasing for the furnace types in the following order: cupola, open-flame forced-draft, crucible, and electric furnace.

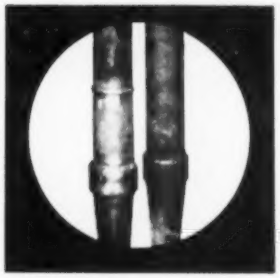
Losses due to volatilization and oxidation can be greatly reduced by the use of protective fluxes during melting. Degassing with oxidizing fluxes having a controlled oxygen content causes lower and more consistent losses than melting without cover in an oxidizing atmosphere. One example may serve to illustrate this. In the melting of gun metal (88% Cu, 10% Sn, 2% Zn) in an uncovered crucible using an oxidizing flame, zinc loss was 0.80%; in melting under a cover of 50% sea sand and 50% fused borax, the zinc loss was negligible; melting under a flux of 33% sea sand, 33% fused borax, 33% CuO, zinc loss was 0.60%; under 25% sea sand, 25% fused borax, 50% copper oxide, zinc loss was 0.50%.

One is reminded that tin oxide forms in preference to copper oxide, so that if tin is added to oxidized copper, all of the oxygen present combines with the tin. When zinc and tin are present, as in gun metal, the oxides of these metals are formed; when phosphorus is present,

(Continued on p. 182)

*Digest of Chapters 4 and 5, "The Melting Process", of the book "Chill-Cast Tin Bronzes", by D. Hanson and W. T. Pell-Walpole, published by Edward Arnold & Co., London, England.

A veteran of 15,000 hours at 1,650°F reconditioned for only $22.50!



ADDING NEW LIFE. When one of the first Inconel radiant tubes ever installed developed a break in the hot leg after four years' use, it was quickly and inexpensively repaired by welding in a new 8-inch section. Note the perfection of the completed weld.

This Inconel® radiant tube is an old timer. But it isn't on its last legs yet – not by a long sight.

At the ELECTRIC AUTO-LITE plant in Toledo, Ohio, the tube racked up 15,000 hours of exceptionally good service. Exceptionally good, we say, because it operated in a pit-type furnace used to batch anneal small parts at 1,650° F. Few tubes last this long, as you've probably found from your own experience.

After four years, a break finally developed – in the firing leg near the welded joint at the burner casting. The rest of the tube was in excellent shape, so Auto-Lite engineers decided on a salvage job.

Toledo's INDUSTRIAL FABRICATING COMPANY re-bored the old burner casting and inserted a new 8-inch section of 3½" OD Inconel tubing with a wall thickness of .109". Using an inert gas shielded arc welding process and "62" Inconel Filler Wire, they joined the new section to the original casting. Then they butt-welded this assembly to the old Inconel tube.

All it cost was $22.50 – and Auto-Lite has a reconditioned Inconel radiant tube that's ready for many more hours of service.

Reports of salvage operations on Inconel wrought furnace and heat-treating equipment are not unusual, for Inconel is one of the most durable high-temperature metals available. Highly resistant to corrosion, embrittlement and destructive oxidation. Inconel serves dependably at temperatures up to 2,200° F. Inconel welds are as heat-resisting and as corrosion-resisting as the alloy itself.

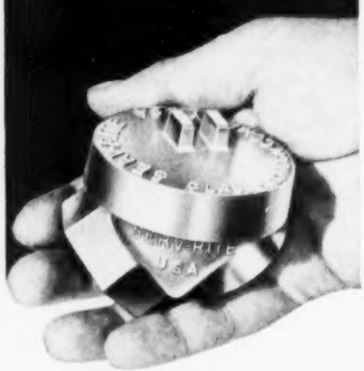
You'll find a great many additional facts about this important alloy in the bulletin, ***Inconel, Workhorse for High Temperatures.*** Your copy is ready and waiting. Write for it now. And consult your distributor of Inco Nickel Alloys for the latest information on availability from warehouse and mill. Remember, too – it always helps to anticipate your requirements somewhat in advance. The International Nickel Company, Inc., 67 Wall St., New York 5, N.Y.

Inco Nickel Alloys

INCO **Inconel**

. . . for Long Life at High Temperatures

"SERV-RITE"
THERMOCOUPLE HEAD



the head that's ahead in every way . . .

This new "Serv-Rite" thermocouple head is actually small enough to be held comfortably in the palm of your hand. But size is only one of the many features that make this thermocouple head really extraordinary. It is loaded with installation and service conveniences that any user of thermocouples will appreciate at once.

The body is of malleable iron, cadmium plated for durability. A new type friction lock assures easy removal or tightening of the cap — a quarter turn does it. An asbestos gasket makes the head dirt- and moisture-proof. With a choice of ½", ¾", or 1" IPS opening for the protecting tube, you can standardize on one style head.

The connector block is of a material especially selected to withstand, without damage, temperatures up to 900° F. in continuous service. Improvements over the conventional type of inserts greatly simplify the making of the lead wire connections. The complete thermocouple element, including connector block, can be easily withdrawn for inspection.

Install a "Serv-Rite" thermocouple head and see for yourself how much better it really is.

Write for complete details

GORDON SERVICE

CLAUD S. GORDON CO.

Manufacturers · Engineers · Distributors

Thermocouples & Accessories • Temperature Control Instruments • Industrial Furnaces & Ovens
Metallurgical Testing Machines

Dept. 15 • 3000 South Wallace St., Chicago 16, Ill.
Dept. 15 • 2035 Hamilton Ave., Cleveland 14, Ohio

The Melting of Chill-Cast Tin Bronzes

(Continued from p. 180)

the phosphates of tin and copper are formed.

Numerous graphs are given and the text goes most thoroughly into the underlying high-temperature chemistry involved in metal melting. A table listing the effects of gas atmospheres on the soundness of bronze castings of varying composition (melted under laboratory conditions) shows that hydrogen is the worst offender and is closely followed by water, while oxygen is much less dangerous and hydrogen sulphide is again a menace.

There is a detailed discussion of furnace types and furnace atmosphere as related to gas absorption. It is stated that a metal having the ideal density 8.7 had a density of 8.37 after melting in a new, freshly annealed crucible; if the crucible was impregnated with a sand and borax flux obtained from previous use, a density of 8.6 was obtained; and, if impregnated with a flux of sand, borax and cupric oxide, a density of 8.68 resulted. The percentages of porosity were 4.5, 1.8, 0.9, respectively.

Gases other than those derived from furnace atmosphere are discussed, and a warning is given as to the use of cathode copper because of the likelihood of its having large quantities of occluded hydrogen. Oxygen-bearing coppers have much lower hydrogen contents.

Attention is given in Chapter 5 to the degassing of molten bronze. Unidirectional cooling, vacuum melting, and melting under inert gases are considered impractical for the ordinary foundry. Bubbling inert gases through the molten metal was found effective. (The method of Spire, whereby a very fine spray of inert gas may be easily passed into the metal in the ladle, should be considered in this connection.)

The greater part of Chapter 5 is devoted to oxidation-reduction treatments. The use of numerous combinations of flux with a variety of bronze alloys is described. It is interesting to note that Lepp is quoted regarding a seventeenth century bell founder whose secret for casting sound bells was that he

(Continued on p. 184)

MERRILL
MATERIALS HANDLING DEVICES

MERRILL BROTHERS
56-31 ARNOLD AVENUE
MASPETH, N. Y.

NEW *Streamlined* AB SPEED PRESS

No. 1330 AB Speed Press, complete for 1" mountings $420.00

No. 1330-2 AB Speed Press, complete for 1¼" mountings $440.00

No. 1330-3 AB Speed Press, complete for 1½" mountings $460.00

The most advanced design in press equipment for speed, convenience, and economy in the production of Bakelite and Transparent Molded Specimen Mounts ever presented to the metallurgist.

A revolutionary feature introduced in this new press is preheated Premolds. The preheat compartment reduces the curing time of thermo-setting molds to one-third of the time usually required. It enables the operator to produce perfect Bakelite Mounts in 2½ to 3½ minutes. All necessary indicators and controls including pressure gauge, pyrometer, thermostats, timer and pilot lights are provided. No experience is required to produce perfect mounts. Automatic ram retraction saves time and effort.

The hinged press head is made with a semi-automatic lock and a hand wheel screw to close the mold securely. Heating blocks are arranged with a magnetic closure to snugly envelop the mold assembly. The interchange of thermostatically controlled heating units of 600 watt capacity is facilitated by convenient supports. Cooling blocks are located in a practical position in front of the press cabinet.

This new speed press is the result of long exacting experiment, with every effort devoted to designing the finest modern specimen press we are able to engineer.

THE BUEHLER LINE OF SPECIMEN PREPARATION EQUIPMENT INCLUDES . . . CUT-OFF MACHINES • SPECIMEN MOUNT PRESSES • POWER GRINDERS • DISC GRINDERS • HAND GRINDERS • BELT SURFACERS • MECHANICAL AND ELECTRO POLISHERS • POLISHING CLOTHS • POLISHING ABRASIVES.

Buehler Ltd.

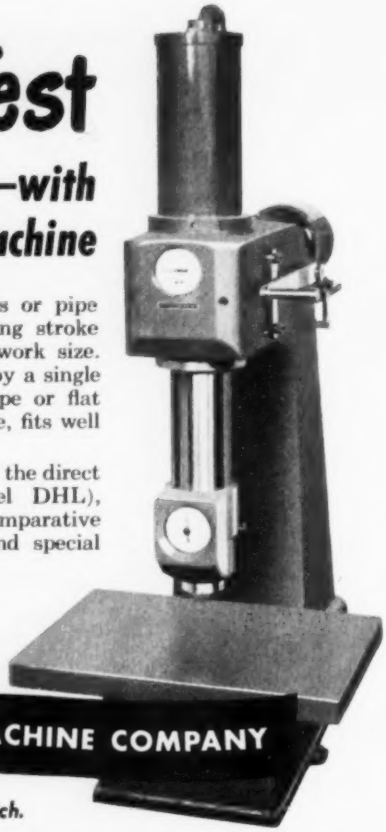
A PARTNERSHIP

165 WEST WACKER DRIVE CHICAGO 1, ILLINOIS

METALLURGICAL APPARATUS

Brinell Test

large pieces fast—with this long stroke machine



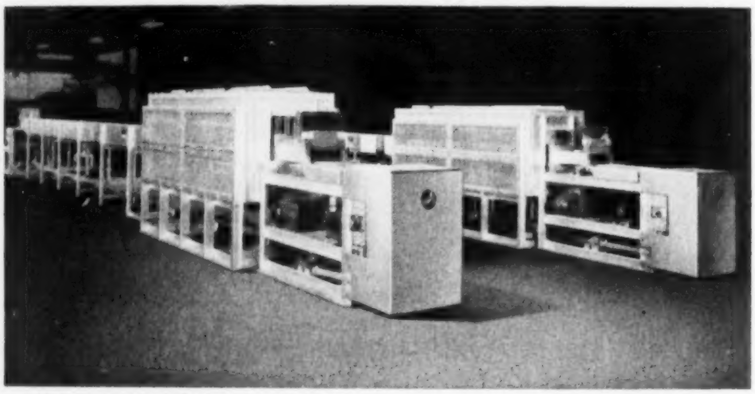
Large awkward castings, forgings or pipe are easily tested because the long stroke eliminates screw adjustment to work size. The hydraulic ram is controlled by a single lever. Large, stationary roller-type or flat table makes work handling simple, fits well into a conveyor line.

Choice of plain Brinell machine or the direct reading machine (shown, model DHL), where dial at end of ram gives comparative hardness immediately. Larger and special machines may also be had.

Write for more information on all our Brinell testing machines.

DETROIT TESTING MACHINE COMPANY

9390 Grinnell Ave., Detroit 13, Mich.



Model HOU-12596-MMB-21 Mesh Belt Furnaces, Maximum Temperature 2100°F.

Another Fabricator Buys

SINTERING FURNACES

Shown above are two Harper Electric Continuous Mesh Belt Furnaces recently installed in the plant of a well-known fabricator of powdered metal products.

Write for detailed information on special and standard high producing Harper Electric Mesh Belt Furnaces.

These quality-built furnaces feature:

- Longer belt life, through improved belt take-up design.
- Closer control of product dimensions through more positive control of preheat temperature.
- Substantial cost saving, through less down time and efficient use of electricity.

HARPER ELECTRIC FURNACE CORPORATION

Department No. 7 • 39 River Street • Buffalo 2, New York

The Melting of Chill-Cast Tin Bronzes

(Continued from p. 182)

added a mixture of copper scale and potash to the metal just before casting; a scientific investigation has just been started to learn what benefits are to be derived from an oxidizing flux in which copper scale is the oxidizing medium.

In regard to the oxidizing fluxes, it is important that these be free from moisture and from water held in combination. A green color of the copper mill scale indicates water and a prefusing of the flux is advised. It is advised that sea sand be used, as this is readily dried. In addition to its use as a component of the oxidizing flux, it is useful as a thickener when thrown on the molten flux just before skimming to assist in the removal of the flux. An enormous amount of data is presented relative to the effect of the various fluxes, and mathematical formulas regarding the reactions involved are discussed. The economics of flux-degassing are presented.

The four requirements which a suitable deoxidizer for tin bronzes must meet are as follows:

1. It must combine with all the oxygen present in the melt and must reduce oxides of the metals or combine with them to form a fluid slag.
2. The products of deoxidation must separate readily from the melt.
3. Any excess of deoxidant required to insure the completion of deoxidizing reactions must not impair the properties of the bronze.
4. The residual deoxidant should be able to prevent further oxidation of the bronze during casting.

The conclusion is reached that phosphorus is the best deoxidizing agent for the purpose, it being unique in the property of preventing further oxidation of the bronze during casting. A short statement on this subject is found at the close of the chapter on the control of solid impurities during melting.

The foundryman will be glad to find at the end of Chapter 5 the heading "Recommended Melting Procedure". Here, all the theoretical discussion and the numerous alternative methods are reduced to a straightforward presentation of how to apply the deoxidizing flux prin-

(Continued on p. 186)

You Can Get Better, Lower Cost Processing of Stainless Steel—These Three Ways:

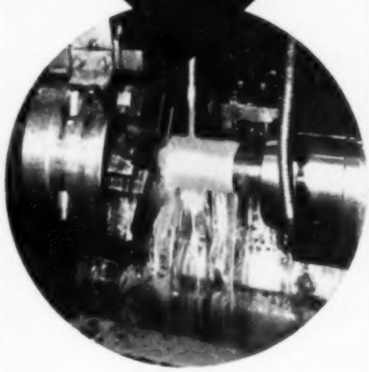
HEAT TREATING

You get more precise heat treating with Houghton Liquid Heats.

Our salt baths devised for stainless steel treatment will preserve the surface. They eliminate danger of inter-granular corrosion, oxidation or other attacks. Heating of parts is uniform and fast.

Houghton salts are carefully compounded to meet predetermined specifications and to remain stable.

MACHINING

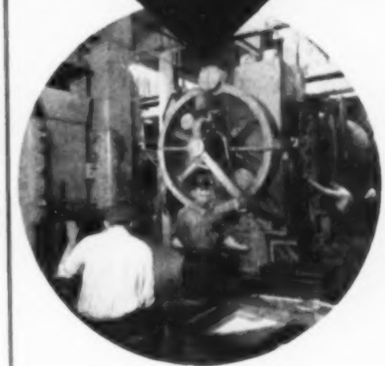


Your machines can turn out better parts, faster, with Houghton Cutting Fluids.

Including highly fortified straight cutting oils for slow speeds, and concentrated bases, both oil- and water-soluble types.

Special emphasis is laid on Antisep All-Purpose Base, used in water emulsions and fortified to provide the lubricity, film strength and anti-welding properties required for machining stainless.

FORMING



Houghton Houghto-Draws assure better finished formed parts, longer die life.

Whether your draws are deep or shallow, simple or complex, there is a Houghto-Draw compound ideally suited to your job. It will provide the film strength and controlled lubricity required for the simplest or toughest drawing job.

Applied by brush, spray or dip, according to your requirements.

For more economical, uniform and productive fabrication of stainless, be sure to take advantage of the metalworking know-how and processing products of Houghton. Call the Houghton Man, or write us, outlining your problem. We'll be glad to help. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

... products of

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service ...

What do you know about the

Moly-sulfide
A LITTLE DOES A LOT

LUBRICANT?

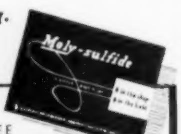
You may have heard about a highly successful solid-film lubricant which is giving remarkable results in the shop and in the field.

In one 40-page booklet we have collected 154 detailed case-histories describing how difficult lubrication problems have been overcome by molybdenum sulfide. If you wish to be up to date about this solid-film lubricant, write for a free copy now.

THE LUBRICANT OF MANY USES

Moly-sulfide
A LITTLE DOES A LOT

Climax Molybdenum Company
500 Fifth Avenue
New York City · 36 · N · Y ·



SEND FOR THIS FREE BOOKLET TODAY

Name ....
Position ....
Company ....
Address ....

MP7 MS-3

The Melting of Chill-Cast Tin Bronzes

(Continued from p. 184)

ciple to foundry work. The essential steps are the making up of two fluxes, one medium oxidizer consisting of equal parts by weight of sea sand, fused borax, and copper mill scale, fused together and kept in an air-tight container; the other a stronger oxidizer consisting of 25% sea sand, 25% fused borax, and 50% copper mill scale. The flux-to-charge ratio is given in the instructions.

This is followed by a discourse on deoxidizing treatments with phosphor copper which will give a residual phosphorus content between 0.015 and 0.020%. Good results have been obtained in crucible heats and with oil-fired reverberatory furnaces. All oxidizing flux must be removed before the treatment is made with the phosphor copper.

It is stated in warning that the benefits to be secured by the recommended melting procedure may be lost unless correct casting methods are used as outlined in Chapter 8.

H. J. ROAST

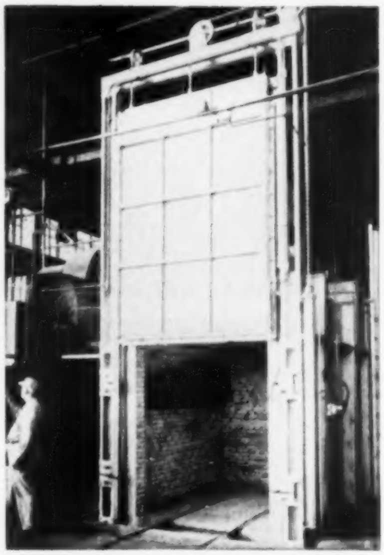
Tool Wear Vs. Metal-Cutting Temperatures*

PRACTICAL EVALUATION of a wide range of tests on machining various metals, ferrous and nonferrous, with both high speed steel and carbide tools, suggests that to obtain the best production results, faster cutting speeds are to be preferred because of shorter machining time and better surface finishes. In addition, heavier feeds are desirable since they reduce machining time. Faster cutting speeds and heavier feeds result in lower workpiece temperatures, but at the same time lead to higher tool temperatures, a primary cause of tool wear and failure. Working out the proper balance becomes the problem.

Furthermore, if the chip becomes too coarse it may also fracture the tool tip. Conversely, fine chips of 0.003 in. or less are much more abrasive to the tool than coarser ones.

(Continued on p. 188)

*Digest of "Metal-Cutting Temperatures and Tool Wear", by A. O. Schmidt, *Tool Engineer*, Vol. 29, July 1952, p. 33-35, and August 1952, p. 51-54.



CARL-MAYER

HEAT TREATING FURNACE for CERIUM MAGNESIUM CASTINGS *at Eclipse - Pioneer Div. of Bendix Aviation Corp., Teterboro, N. J.*

(Patents Applied For)

DIMENSIONS: 6'-0" wide x 7'-0" high x 10'-0" long (clear work space). Also built in other sizes to meet individual requirements.

TEMPERATURE: 300° F. to 1100° F.

ATMOSPHERE: SO_2.

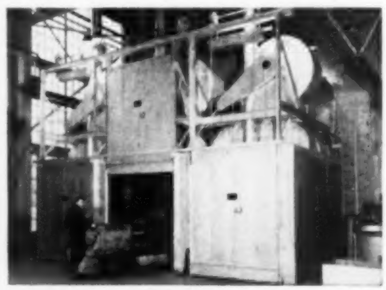
DOOR: Lift type, counterbalanced, with air cylinder for automatic operation.

METHOD OF HANDLING MATERIAL: Steel racks with wheels.

TRACKS: Retractable before door is lowered, to permit tight door seal.

CONSTRUCTION: Heavy steel plate exterior with refractory lining. Air tight.

HEATER: Recirculating-type electric external air heater on furnace roof.



AGING OVENS *in Large Aluminum Foundry*

DUCT SYSTEM: Drop ducts on oven walls assure more uniform temperature control.

WALL CONSTRUCTION: Mayer patented triple slotted insulated steel panels. Patent No. 1843430.

THE CARL-MAYER CORP.
3030 Euclid Ave., Cleveland, Ohio

TOOL STEEL THAT MACHINES 30% FASTER NOW AVAILABLE IN HOLLOW BAR FORM

ADVANTAGES OF GRAPH-MO

MOST STABLE TOOL STEEL MADE
OUTWEARS OTHERS 3 TO 1
MACHINES 30% FASTER
MINIMUM TENDENCY TO PICK UP, SCUFF OR GALL
UNIFORM RESPONSE TO HEAT TREATMENT

PLUS

ADVANTAGES OF HOLLOW BARS

NO DRILLING
FINISH BORING IS FIRST STEP
LESS MACHINING TIME
LESS SCRAP LOSS
MORE PARTS PER TON OF STEEL

EQUALS

ADVANTAGES OF

GRAPH-MO HOLLOW-BAR

NEW GRAPH-MO® HOLLOW-BAR COMBINES THE FASTER MACHINING AND LONGER WEAR OF GRAPH-MO WITH THE ECONOMY OF A HOLLOW BAR SECTION

Now manufacturers of ring-shaped tool steel parts can get all the proven advantages of Graph-Mo® steel *plus* the economies of a hollow bar section in Graph-Mo Hollow-Bar—a new graphitic tool steel product in hollow bar form developed by the Timken Company.

The center hole's already in Graph-Mo Hollow-Bar. Drilling is eliminated. You save machining time, cut scrap loss, get more parts per ton of steel.

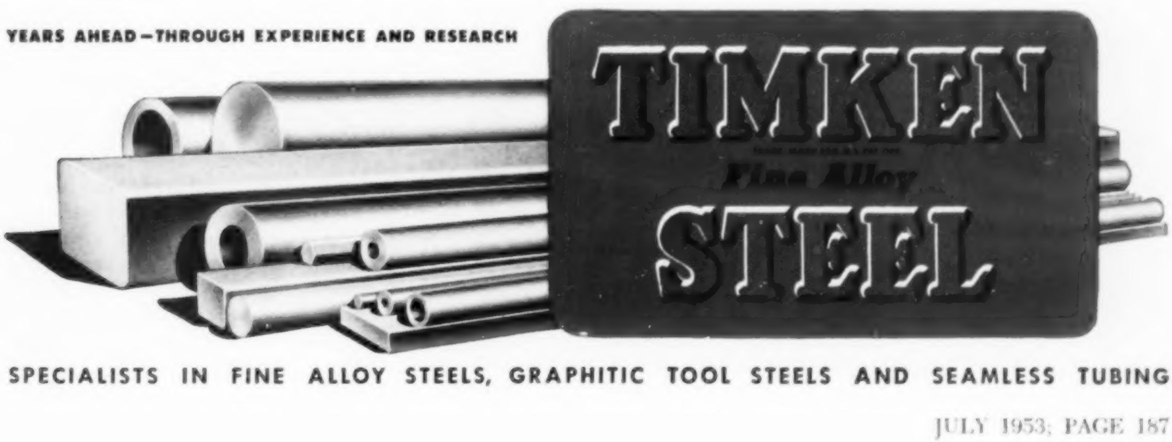
Graph-Mo is a different kind of tool steel. Free graphite in its structure makes it 30% easier to machine! And the combination of free graphite and diamond-hard carbides gives it unusual wear-resistance. Users report it outwears other tool steels an average of 3 to 1!

Stability tests prove Graph-Mo is the most stable tool steel ever made. After 12 years, a typical Graph-Mo steel master plug gage showed less than 10 millionths of an inch dimensional change! It responds uniformly to heat treatment, has a minimum tendency to pick up, scuff, seize or gall.

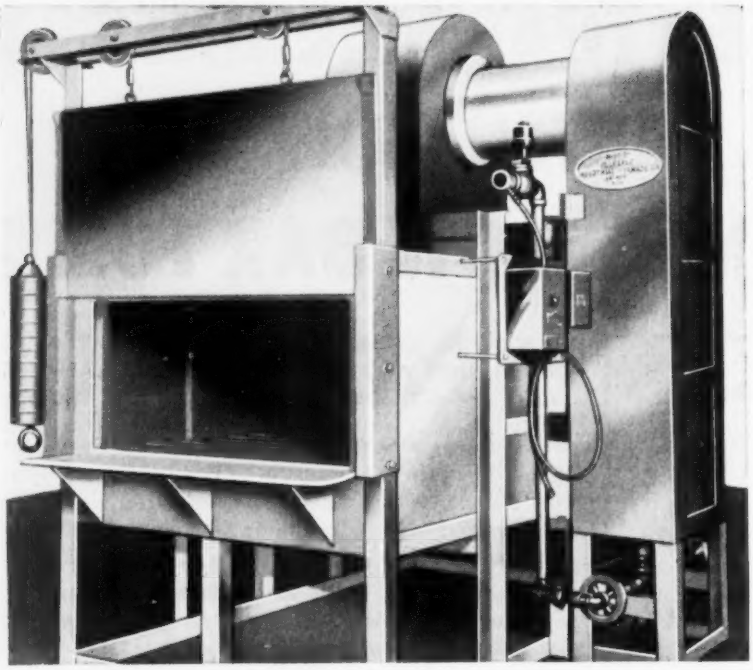
If you make ring gages, dies or other ring-shaped tool steel parts, make sure you're getting *all* the advantages of Graph-Mo Hollow-Bar. Sizes range up to 16" O.D. with a variety of wall thicknesses. Graph-Mo Hollow-Bar is distributed through A. Milne and Co. and Peninsular Steel Co. warehouses.

For more information about Graph-Mo Hollow-Bar, write The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



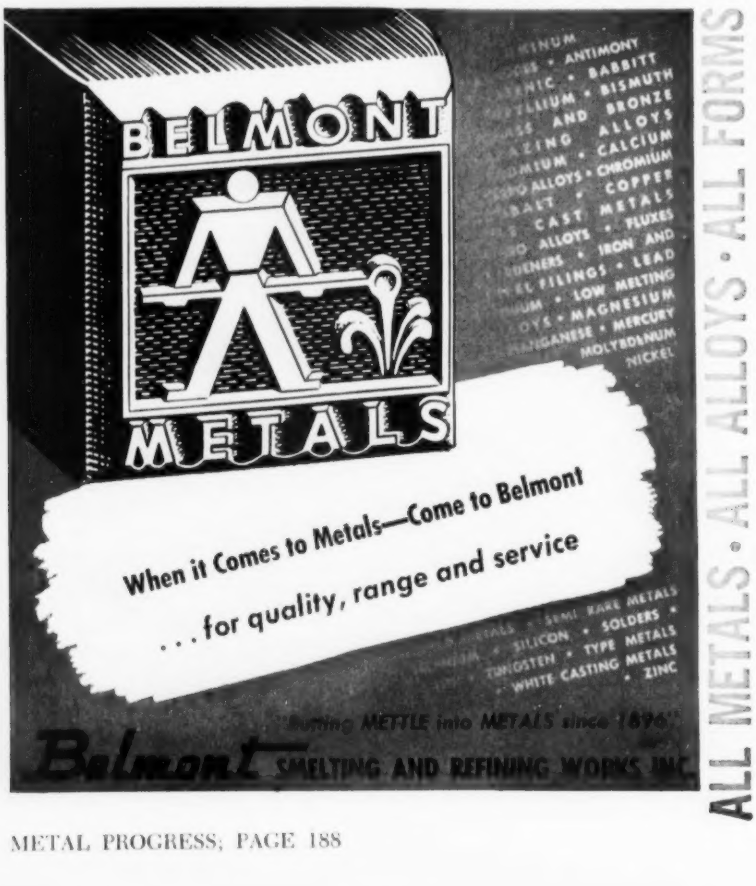
SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING



Batch-type furnace—for the heat treating of aluminum alloys—consists of atmosphere-type burner, mounted on the lower end of the combination chamber to reheat the recirculated hot air through the furnace. A High Heat insulated recirculating fan is standard equipment for recirculating the heated air. This method of heating holds temperature with little or no variation. Mounting the burner in the duct eliminates the necessity of an extra heating unit. . . . Send us your heat treating problems . . . our engineers will make a proposal without obligation.

Bellevue INDUSTRIAL FURNACE COMPANY

2626 Crane — Est. 1910 — Detroit 14, Michigan



Tool Wear Vs. Metal-Cutting Temperatures

(Continued from p. 186)

Rake angles influence tool forces and chip flow, thus requiring discrimination in their selection. Negative rake angles usually are necessary only when additional strength must be provided at the cutting edge of a carbide tip. However, a negative ridge superimposed upon a tip positioned at a positive rake angle will furnish added strength, result in less tool wear and easier regrinding.

Very fast cutting speeds usually result in more rapid abrasion and failure of the tool, although there are operations in which cutting speeds faster than those generally recommended are beneficial, as milling at comparatively light feeds.

General recommendation for machining mild steel with carbide tools calls for cutting speed between 300 and 800 ft. per min., with a feed between 0.006 and 0.020 in. per tooth. Lighter feeds and faster speeds are used when shallow cuts are to be taken, and when smooth surface finishes are desired. Heavier feeds and slower cutting speeds are used for roughing cuts.

The author draws attention to the following points with regard to temperatures in machining operations:

1. Tool-tip temperature is the most important temperature value in the complex thermal state of a metal-cutting operation.
2. With an increase in cutting speed, tool-tip temperatures increase and workpiece surface temperatures, after machining, decrease.
3. With an increase in feed, tool-tip temperatures will increase and workpiece surface temperatures, after machining, decrease.
4. Workpiece surface temperatures, after machining, as well as average chip temperatures and tool temperatures, all increase with an increasingly negative rake angle.
5. After a certain period of operation, tool wear will require higher cutting forces, involving greater power consumption and also higher temperatures in tool and workpiece.

A carefully considered engineering review of every new production machining setup is essential to arrive at that point where maximum tool life and production, and thus lowest cost, have been attained.

ALL-PURPOSE TOOL

...for Research and Production Control

RCA ELECTRON MICROSCOPE
(Model EMT-3)

Training Assistance. A plus value offered by RCA to purchasers of Electron Microscopes is the initial training of their personnel in the fundamentals of Electron Microscopy. Operation and application of the instrument are fully demonstrated at RCA by skilled staff technicians.

Wide-range magnification and easy operation now make the RCA Table Model Electron Microscope the basic buy for every research or production control laboratory.

Spanning a range that begins within the capabilities of the light microscope range and extends to photographic magnification of 40,000 X—the RCA Electron Microscope Model EMT-3 has taken its place among basic laboratory instruments.

Before you invest in another piece of laboratory equipment, investigate the RCA Electron Microscope (Model EMT-3) as a way to more precise results and greater speed. For information write: Radio Corporation of America, Scientific Instruments, Dept. 72S, Camden, N. J.

Magnifications 1500X—3,000X—6,000X
(to 40,000 X photographically)
Permits untrained personnel to progress directly from light microscopy to electron microscopy.

Instant photography and specimen changing
20 exposures without breaking vacuum—with new roll film camera.

Permanent-Magnet Lenses
Precision lenses offer exceptional stability for the most exacting studies.

50KV Accelerating Voltage
Drive is comparable to that offered in large, high-priced equipment.

RCA

SCIENTIFIC INSTRUMENTS
RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

- Electron Microscopes
- Vacuum Units
- Shadow Caster
- Vacuum Leak Detector
- Electron Diffraction Equipment

the first step

TO SOLVE YOUR HIGH-TEMPERATURE PROBLEM


HIGH TEMPERATURE WORK SHEET

A simplified form to describe your material problem for study and suggestions

THE INTERNATIONAL NICKEL COMPANY, INC.
DEVELOPMENT and RESEARCH DIVISION
67 Wall Street - New York 5, N. Y.

This coupon will bring you our High Temperature Work Sheet so that you can turn your troubles over to Inco's High Temperature Engineering Service for analysis and suggestions. No obligation whatsoever, of course, whether they recommend an Inco Nickel Alloy or some other material as the most practical answer to your particular problem.

INCO

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.
Please send me the High Temperature Work Sheet so that I may outline my problem to you.

Name ______________________

Company ______________________

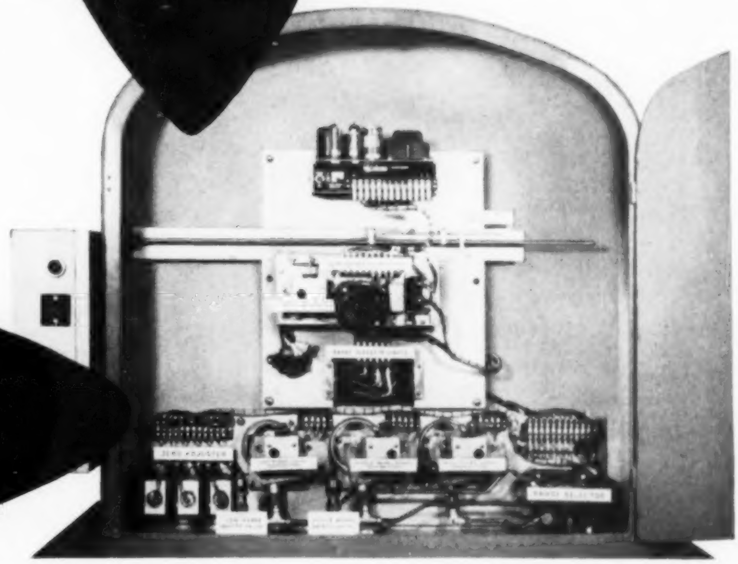
Address ______________________

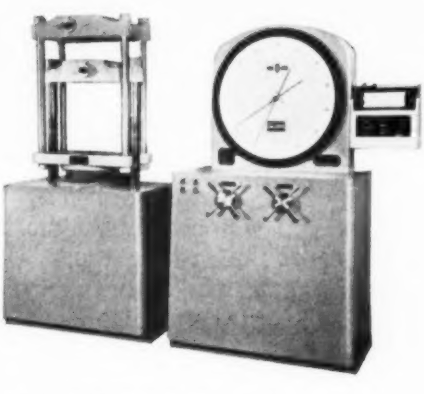
City ______________ State ____________

the heart of

TWO GREAT LINES OF SUPER "L" TESTING MACHINES

the OLSEN SelecΦrange INDICATING SYSTEM





Typical 120,000 lb. Standard Super "L" U.T.M. with electronic recorder

Testing engineers all over the world recognize the inherent simplicity, accuracy, speed of response and dependability of the Olsen electronic null weighing system which is the heart of the Olsen Standard Super "L"—for standard size specimens, and the DeLuxe Super "L", with extra-large clearances—for oversize specimens.

These two lines of modern testing machines give you all the advantages of the exclusive Olsen SelecΦrange Indicating System:

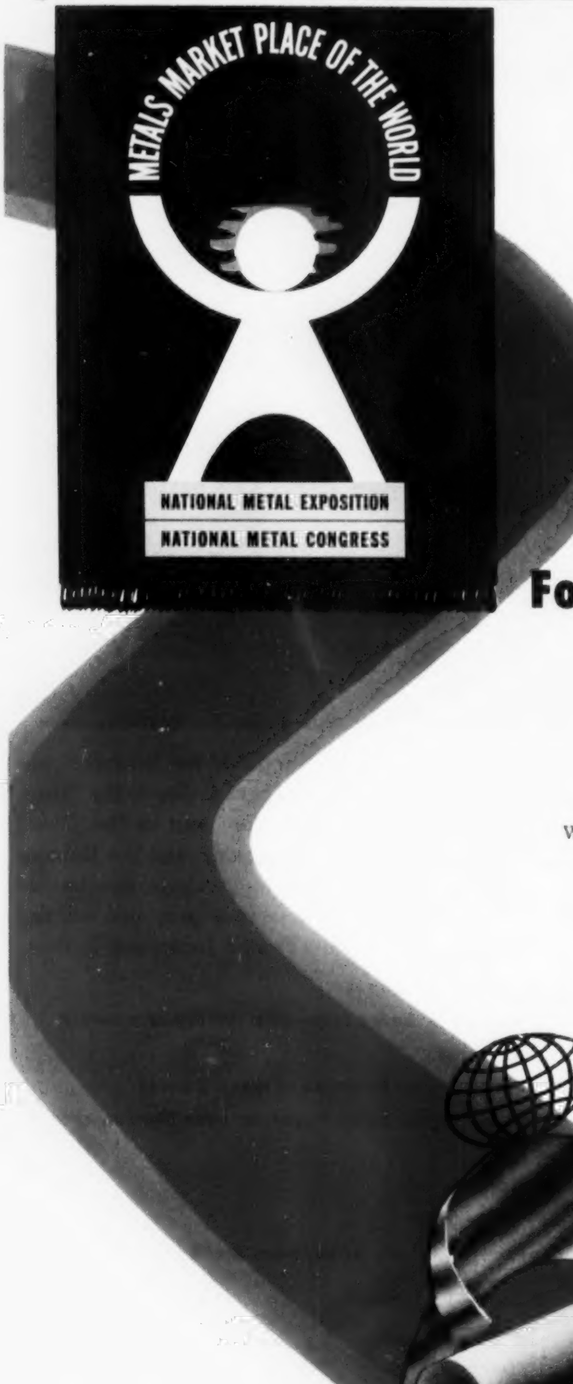
- ***50 to 1 spread of testing ranges***
- ***Instant change of ranges during test—with the flip of a switch***
- ***Electronic zero adjuster***
- ***Positive load indication—no backlash of moving parts***
- ***Individually lighted ranges—color keyed for easy identification***
- ***Simple controls***
- ***Foolproof construction***
- ***Automatic safety controls***
- ***Accuracy—meets all A.S.T.M., Army, Navy and Federal specifications***
- ***Low cost***

Get all the facts about the Olsen SelecΦrange *Indicating System and the many other features that distinguish Olsen Super "L" testing machines.*

Testing & Balancing Machines

TINIUS OLSEN
TESTING MACHINE CO.
2030 Easton Road · Willow Grove, Pa.

Write for your copy of Bulletin 47 today.



Royal Welcome

For America's most honored *Guests*

At no other place and at no other time in 1953 will the power and vitality and productive genius of the vast and basic metals industries of America be so forcefully and so clearly demonstrated as in Cleveland's Public Hall this October.

Here . . . in bold, animated, live-action display will be the newest . . . the finest . . . the most wanted developments . . . and here, too, will be the alert, the wise, the idea-seeking men who make the metals industries go forward.

NATIONAL METALS EXPOSITION AND CONGRESS

Cleveland, Ohio Oct. 19-23

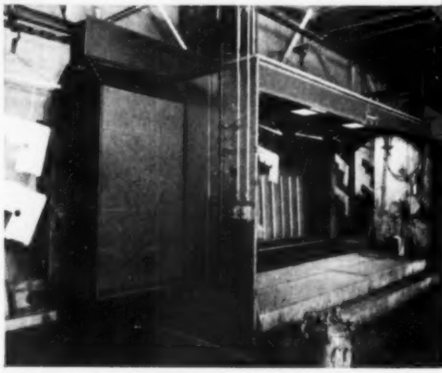
COMPLETE *Finishing* SYSTEMS

. . . for ENAMELS • LACQUER • PAINT • VARNISH

. . . the EXPERIENCE that goes into the PLANNING and ENGINEERING of MAHON EQUIPMENT is the item of GREATEST VALUE to YOU!

Exit end of Mahon Two-Conveyor-Line Metal Cleaning and Rust Proofing Machine at American-Standard, Buffalo, N. Y.

Entrance end of Mahon Metal Cleaning and Rust Proofing Machine with two parallel conveyor lines. Note combined Dry-Off and Finish Baking Oven overhead at right.



One of four Mahon Conventional Type Hydro-Filter Spray Booths with 'Hydaire" Flood Sheet—part of the Complete Mahon Finishing System at American-Standard.

Mahon Overhead, Bottom Entrance, Combined Dry-Off and Finish Baking Oven at American-Standard. Dry-Off section is at the right. Temperature Control is Automatic.

American-Standard Products Receive Their Fine Finish in Mahon Equipment!

Illustrated here are major elements of one of two Complete Finishing Systems recently installed by Mahon in the Buffalo Stamping Plant of American-Standard. In this particular system, which is ultramodern in every respect, jackets and other metal parts of residential heating and cooling units are carried through the entire system on two parallel conveyor lines. Metal Cleaning and Rust Proofing is accomplished on the two conveyor lines in a single processing tunnel. The two parallel conveyor lines then carry parts through an overhead bottom entrance, single-pass Dry-Off Oven which is an integral part of the Finish Baking Oven. Parts on each of the conveyor lines then pass through two conventional type Hydro-Filter Spray Booths, staggered right and left hand, where the finish is applied. Finish is baked while the two parallel conveyors make a double pass circuit in the finish baking section of the overhead oven. This is a typical Mahon engineered Finishing System. If you are contemplating new finishing equipment, you too, will find that Mahon engineers are better qualified to do the all-important planning and engineering which is the key to fine finishes at minimum cost . . . and you will also find Mahon equipment more economical to operate over a longer period of time. See Mahon's Insert in Sweet's Plant Engineering File for further information, or write for Catalog A-653.

THE R. C. MAHON COMPANY

HOME OFFICE and PLANT, Detroit 34, Mich. • WESTERN SALES DIVISION, Chicago 4, Ill.

Engineers and Manufacturers of Complete Finishing Systems—including Metal Cleaning and Pickling Equipment, Metal Cleaning and Rust Proofing Equipment, Hydro-Filter Spray Booths, Filtered Air Supply Systems, and Drying and Baking Ovens; Core Ovens, Heat Treating and Quenching Equipment for Aluminum and Magnesium, and other units of Special Production Equipment.

MAHON

Tempilstiks°

A simple method of controlling temperatures in:

- WELDING
- FLAME-CUTTING
- TEMPERING
- FORGING
- CASTING
- MOLDING
- DRAWING
- STRAIGHTENING
- HEAT-TREATING IN GENERAL

Also available in pellet and liquid form

It's this simple: Select the Tempilstik° for the working temperature you want. Mark your workpiece with it. When the Tempilstik° mark melts, the specified temperature has been reached.

$2 each gives up to 2000 readings

Available in these temperatures (°F)

113	263	400	950	1500
125	275	450	1000	1550
138	288	500	1050	1600
150	300	550	1100	1650
163	313	600	1150	1700
175	325	650	1200	1750
188	338	700	1250	1800
200	350	750	1300	1850
213	363	800	1350	1900
225	375	850	1400	1950
238	388	900	1450	2000
250				

FREE —Tempil° "Basic Guide to Ferrous Metallurgy" — 16¼" by 21" plastic-laminated wall chart in color. Send for sample pellets, stating temperature of interest to you.

GORDON SERVICE

CLAUD S. GORDON CO.
Manufacturers & Distributors
Thermocouple Supplies • Industrial Furnaces & Ovens
Pyrometers & Controls • Metallurgical Testing Machines
Dept. 15 • 3000 South Wallace St., Chicago 16, Ill.
Dept. 15 • 2035 Hamilton Ave., Cleveland 14, Ohio

Metallurgical Factors Affecting Machinability*

In any machining process, the optimum cutting conditions involve the metal being cut, the cutting tool, the mechanical equipment and the cutting fluid. For any one material, one combination of machining conditions will be the most suitable. The choice is determined largely by the machinability of the stock involved.

The machinability of any steel is determined by the ease and economy of power with which a chip can be removed from its surface. If the steel is hard, the tool cannot readily penetrate its surface; if it is soft and ductile, the metal may spread under the pressure of the tool and the cutting edge of the tool will become buried in the soft metal. The machinability of either a very soft or a very hard steel can be improved by a heat treatment which eliminates such conditions.

Metallurgical factors affecting machining properties of a steel include: *(a)* method of steel manufacture; *(b)* composition; and *(c)* heat treatment, metallographic structure and mechanical properties.

An example in connection with the first factor is the excellent machinability of the bessemer screw steels, a property which is widely recognized. This property derives primarily from the relatively high sulphur content, but also from the absorption of nitrogen.

With regard to the composition factor, best machinability appears to be associated with an optimum hardness and brittleness and since they — all other things being equal — are dependent upon composition, any increase in the amount of an element in the steel which increases hardness and brittleness beyond the optimum level should be accompanied by a corresponding decrease in the amount of other hardening elements present if the best machinability is to be realized.

Machinability can be improved if the continuity of the ductile matrix is interrupted by the presence of brittle or weak constituents or inclu-

(Continued on p. 196)

*Digest of "Metallurgical Aspects of Machinability of Steel", by W. I. Pumphrey, *The Welder*, Vol. 21, July-September 1952, p. 63-68, and October-December 1952, p. 85-90.

ROCKWELL
ELECTRIC
Convection Type
PIT FURNACES

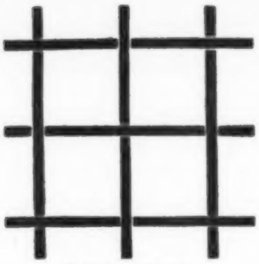
FOR AIR DRAWING
TEMPERING • AGING
ANNEALING TO 1250°F.

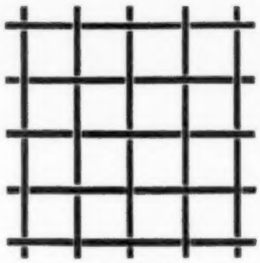
For heating small parts in a basket or larger pieces on a rack. Uniform, controlled heating assured by high velocity heat circulation through the charge. High production rate in minimum time and space. Four standard sizes with charge capacity of 0.55 – 2.3 – 14.4 and 68.7 cu. ft. Other sizes and gas-fired units built to requirements.

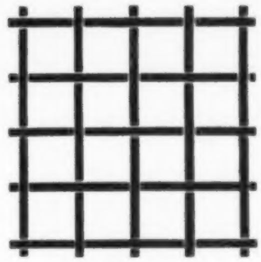
Write for Bulletin 433.

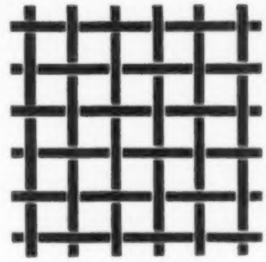
ROCKWELL SINCE 1888 BUILT

W. S. ROCKWELL COMPANY
FURNACES • OVENS • BURNERS • VALVES • SPECIAL MACHINERY
2043 ELIOT STREET • FAIRFIELD, CONN.

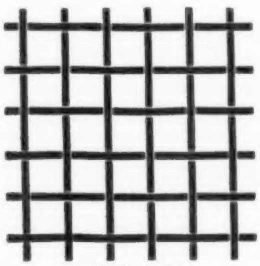

2 Mesh .063"
76.4% Open Area

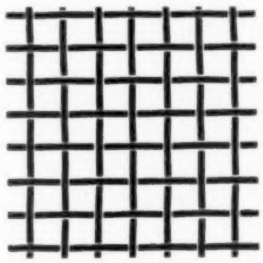

3 Mesh .041"
76.7% Open Area

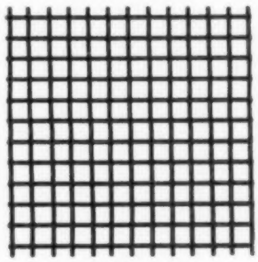

3 Mesh .054"
70.1% Open Area

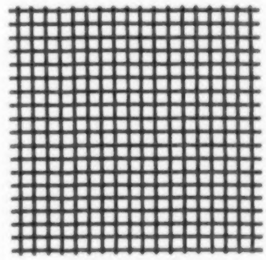

4 Mesh .063"
56.0% Open Area

CALL CHASE

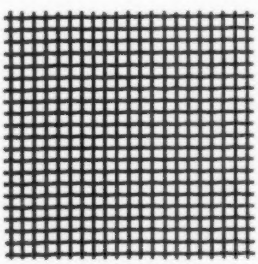

4 Mesh .047"
65.9% Open Area

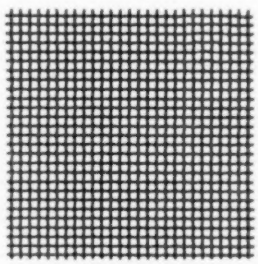

5 Mesh .041"
63.2% Open Area

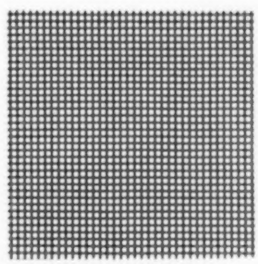

8 Mesh .028"
60.2% Open Area

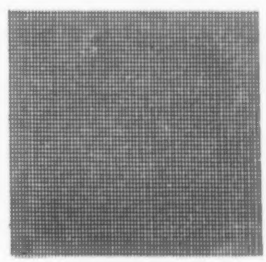

12 Mesh .023"
51.8% Open Area

FOR INDUSTRIAL WIRE CLOTH


14 Mesh .020"
51.0% Open Area


18 Mesh .017"
48.3% Open Area


24 Mesh .0135"
45.8% Open Area


50 x 40 Mesh .009"
35.7% Open Area

IN BRASS AND COPPER

From coarse wire cloth for window or door grilles . . . right down to extra-fine mesh for food preparation, call Chase.

Double crimped wires of Chase Wire Cloth keep openings square and true . . . mesh uniform. It is woven in a mill which specializes in weaving brass, copper and copper-alloy wire cloth. The result is *quality*.

For information on the size and type wire cloth *you* need, send for free book or call your nearest Chase warehouse.

Chase
BRASS & COPPER

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

Albany† Atlanta Baltimore Boston Chicago Cincinnati Cleveland Dallas Denver† Detroit Houston Indianapolis Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York Philadelphia Pittsburgh Providence Rochester† St. Louis San Francisco Seattle Waterbury (†sales office only)

"Sorry I did it, Sam, but when you told me you forgot to re-order my OILDIE tool steel I guess I just lost my head."

COLUMBIA TOOL STEEL COMPANY • CHICAGO HEIGHTS, ILL.

Producers of fine tool steels—High Speed Steels Die Steels—Hot Work and Shock Resisting Steels Carbon Tool Steels.

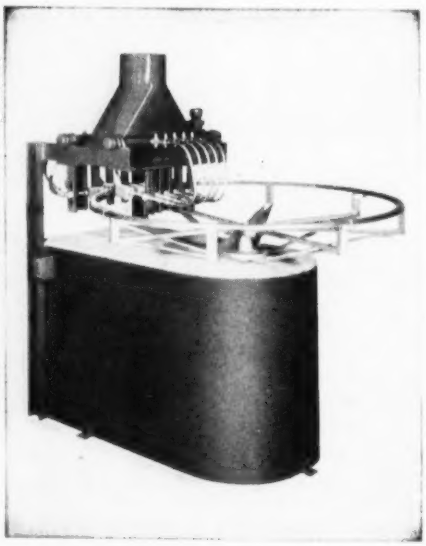
TOOL COLUMBIA STEELS

SPEED in Localized BRAZING, ANNEALING HARDENING

(up to 3000 units per hour)

G. A. S.
(Gas-Fired)
HIGH SPEED
HEATING UNITS

- Use city gas and air equipped with high speed burners.
- Handle large variety of sizes and shapes. Available with stationary or rotating holding fixtures.
- Production rates as high as 3,000 pieces per hour.
- Now being extensively used for brazing bomb and shell assemblies, annealing cartridge cases, etc.
- For further details on G.A.S. Turntable and Conveyor-Type Heating Units, write for Bulletin No. 511.



G.A.S. Standard Turntable Heating Unit with variable speed drive

GAS APPLIANCE SERVICE, INC.
Industrial Gas Engineers
1201 WEBSTER AVENUE • CHICAGO 14, ILLINOIS

Metallurgical Factors Affecting Machinability

(Continued from p. 194)

sions. The presence of small lead particles also is helpful in this direction, although their exact function is not clearly understood. Inclusions, however, while weak and brittle, should not be so hard as to be abrasive to the cutting tool. Silicate inclusions have this undesirable effect.

On the score of the third metallurgical factor, a good machining steel should have a minimum tendency to become work hardened but a high tendency to become work embrittled. Machining properties appear to improve with increase in grain size, thus favoring hot working of the steel at a temperature above the grain-coarsening point prior to machining. Considerably better machinability, however, can be obtained with cold worked steel, although the relative advantages of hot working and cold working depend in a measure upon composition. For example, mild steels with up to about 0.3% C machine best in the cold worked condition; those containing 0.3 to 0.4% C show little difference in either condition; and those having more than 0.4% C, as well as alloy steels having more than 0.3% C, tend to be inferior in the cold worked state and should be annealed before machining.

For best machinability, a steel should have a uniform microstructure throughout its section. Steels of low hardenability often exhibit poor machining properties in the heat treated condition, partly because of the nonuniform hardness across their section but mainly because of the nonuniform microstructure.

There is no direct correlation between room-temperature hardness and machinability.

Tensile properties as determined under normal conditions of testing likewise give no reliable indication of machining qualities. This is understandable, since any such correlation would have to depend upon mechanical properties being determined under high rates of strain such as exist in any machining operation.

Steels of similar composition and hardness but having different metallographic structures may differ considerably in machining quality.

A. H. Allen

Customer Reports:

Asarco Continuous-Cast Bronzes Machined at Over 1,000 Feet Per Minute

WORTHINGTON CORPORATION has jumped machining speeds on shaft bushings and pump sleeves by using ASARCO Continuous-Cast Bronzes instead of foundry-cast bronzes. In some cases over 1,000 surface feet are machined per minute.

Worthington has used very substantial quantities of ASARCO Continuous-Cast Bronzes during the last three years in a variety of alloys and sizes. Tool life is longer despite high cutting speeds. Products are improved because ASARCO stock has greater uniformity than conventional foundry products, and its even dispersion of lead particles provides superior bearing surfaces.

ASARCO Continuous-Cast Bronzes are entirely free from porosity, and from hard and soft spots . . . are ideal for use on automatic screw machines. No sand, dirt, dross or other foreign matter is trapped in the stock to harm tools or discourage high cutting speeds. Dimensions are so precise that many machining operations are eliminated and waste is at a minimum. Impact and fatigue characteristics are up to 100% better than those of sand-cast bronzes. Yield and tensile strengths are superior, too. Stock is available in any length up to 20′ to meet individual requirements.

REDUCE MACHINING TIME! . . . IMPROVE PRODUCTS! . . . CUT SCRAP LOSSES! Buy ASARCO Continuous-Cast Bronzes and get bronzes with superior properties in the exact sizes you need.

ASARCO CONTINUOUS-CAST RODS · TUBES · SHAPES ®

West Coast Agent:
KINGWELL BROS., LTD., 457 Minna St., San Francisco, Calif.

American Smelting and Refining Company

OFFICES: Perth Amboy Plant, Barber, New Jersey
Whiting, Indiana

Luster-on®

Treats More Square Feet Per Gallon

Luster-on Khaki or Olive Drab offers up to 3500 square feet per gallon of treated work. Why settle for less?

Luster-on®

Gives More Hours of Resistance

Luster-on and baked lacquer offer up to 1000 hours resistance on your bright finishes to 100% humidity at 120°F. Corrosion protection is phenomenal. Why settle for less?

You don't have to settle for less if you always specify Luster-on — the original passivating cold bright dip for zinc; also available for Khaki or Olive Drab protective finish. Gives uniform paint bond for die castings.

"The first in the field and still the leader."

Write for free data sheets and send a part for free processing.

THE *Chemical* CORPORATION

70 Waltham Ave., Springfield 9, Mass.

Ductile Chromium*

IN THE COURSE of a study of the properties of very pure chromium metal, personnel of the Albany Field Station of the U. S. Bureau of Mines observed marked ductility at temperature of liquid air. Reductions of 40 and 60% by cold forging were reported for chromium which had been soaked in liquid air prior to working. Chromium at room temperature is extremely brittle and indeed must be worked above 950° F. Therefore, this behavior constituted quite a surprising anomaly.

One possibility, as an explanation, would be that chromium has an allotropic transformation at some subzero temperature. To investigate this, a piece of chromium sheet, 0.006 in. thick, was obtained from the Bureau of Mines, reported to contain under 0.1% total metallic impurities and approximately 0.003% oxygen.

Its crystalline structure at +70° F. and −275° F. was determined in a North American Philips Co. X-ray diffractometer. During the low-temperature observations the sheet was cooled by a blast of dry air, emerging from copper coils in Dewar flasks containing liquid oxygen and liquid nitrogen. Temperature readings were from a thermocouple mounted on the specimen directly under the air stream, but outside the X-ray beam.

X-ray patterns at both temperatures were identical (the characteristic alpha-tungsten body-centered cubic structure) except for dimensional changes due to thermal expansion. Expansion noted from −275 to +70° F. was 0.0000023 per °F., which checks fairly well the U. S. Bureau of Standards' figure of 0.00000215.

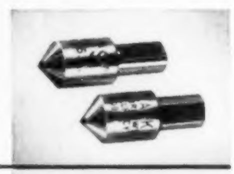
Since this sample showed no crystallographic change, the (somewhat negative) conclusion must be reached that chromium's unexpected ductility at low temperature is due to some other phenomenon. It is suggested that this property (of high ductility at very low temperatures) may be related in some way to rheotropic embrittlement.

*Digest of "Low Temperature Crystallography of Chromium", by Lt. E. F. Becht, Technical Note WCRT 53-69, April 10, 1953, Materials Laboratory, Wright Air Development Center, Dayton, Ohio.

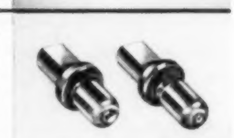
Call on CLARK

for All Your "Rockwell Testing" Needs

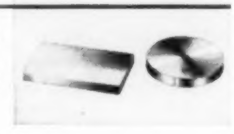
CLARK Diamond Cone Penetrators are exactly right for your "Rockwell" hardness tester, whether or not it bears the CLARK name. Every step in their manufacture, from careful diamond selection to expert lapping, leads to a precision product that will give you precision results. Yet CLARK Diamond Penetrators cost surprisingly little.



CLARK Steel Ball Penetrators, for accurate "Rockwell testing" of unhardened steel, cast iron, brass, bronze, and similar materials, are available in all standard sizes.



CLARK Test Blocks, in various hardness grades, provide a quick, sure, and simple method of checking the accuracy of your "Rockwell" type hardness tester.



Write today for descriptions and prices.

CLARK INSTRUMENT, INC.
10202 Ford Road • Dearborn, Mich., U.S.A.

CLARK

DEEP DRAWS IN ONE OPERATION MADE POSSIBLE BY USE OF MAGNESIUM

Forming MAGNESIUM at elevated temperatures gives deeper draws which eliminate need for multiple die sets and repeated drawing

An outstanding advantage of magnesium is its deep-drawing properties at elevated temperatures. Compared to other metals, magnesium can be drawn from three to four times deeper in a single operation.

This often means the elimination of multiple sets of dies and repeated annealing and drawing. When designed in magnesium, parts can be drawn in one piece which in other metals could be economically fabricated only by joining separate pieces together. The result is a more pleasing design and a considerable saving in time and labor. It amounts to a considerable saving in cost, too.

Generally, magnesium parts can be drawn to a depth of from 1½ to 2 times the minimum width of the blank in a single operation. Where a circular blank is used, the depth of draw in one operation can be twice the diameter of the blank. Also, hot forming reduces allowance for spring back to a minimum or actually eliminates it.

Whatever your fabrication methods, you will find that magnesium today is a practical metal. Add to that its functional advantages of light weight and high strength and you have a metal worth investigating. For further information, write to THE DOW CHEMICAL COMPANY, Magnesium Department, Midland, Michigan.

you can depend on DOW MAGNESIUM

UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic . . . . Organic . . . . Decorative . . . . Protective

"Heavy" coatings deliver heavy duty protection

Many chromium plating difficulties eliminated

Over 700 commercial installations of the Unichrome SRHS Chromium Bath have shown that this bath virtually obsoletes the ordinary chromium plating solution. Again and again, results have confirmed each improvement this solution offers; each difficulty it has reduced or eliminated. Here are its chief advantages:

In hard chromium plating of machined parts, its greater leveling action has reduced subsequent grinding and polishing time. The bath also has less tendency toward building up "trees" or nodules at edges.

SRHS Chromium also means less loss of fatigue strength in chromium plated steel. In some cases, parts may be redesigned for lighter and smaller cross sections.

Important chemical constituents of the bath are controlled automatically—maintaining the solution at top plating balance. This has slashed control time and maintained plating quality.

Higher plating speeds have been achieved—with plating time cut more than 50% in some plants, and capacity of existing equipment increased.

This solution's wider bright plate range has reduced "burning" on edges and "missing" in recesses, thereby further cutting rejects.

Call in a United Chromium engineer for complete facts. Or write for new bulletin SRHS-2.

Ucilon Coatings protect largest plating machine against corrosion

With their highly corrosive solutions and high humidity, plating departments make an ideal proving ground for protective coating systems. Ucilon Coating Systems on equipment have given 2, 3, and more years of service in many plating plants despite the severity of the service.

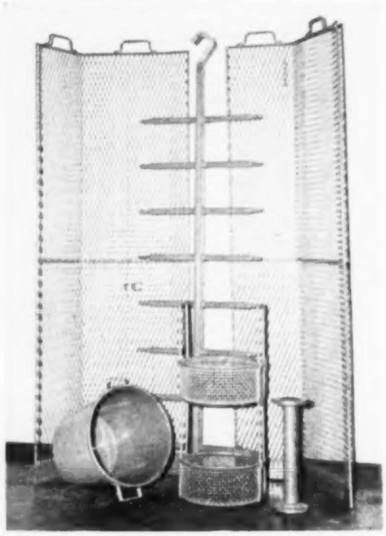
It was because of this durability under severe conditions that they were specified for protecting the largest wire plating machine at the plant of a famous concern.

Details on the various types of Ucilon* Coatings are presented in Bulletin No. MC-7. Write for your copy.

**Trade Mark*

Unichrome Plastisol Compounds winning battles against strong chemical attack and corrosion

Plastisol compounds offer engineers a material with unusually valuable design and maintenance possibilities. They provide the three properties required for durable service in a wide variety of severe applications. They can profitably supplant rubber for some end uses, and protective maintenance coatings in others.



Tank screens, plating rack, drum, dipping basket and flanged pipe that obtained extraordinary chemical resistance with Unichrome Plastisols

WHY PLASTISOLS ARE UNIQUE

(1) They are highly chemical resistant. Produced from vinyl resins and plasticizers, Unichrome Plastisol Compounds display great resistance not only to acids and alkalies, but also to water, salts, oxidizing agents and many other corrosives.

(2) They are resilient. While Unichrome Plastisol formulations can be modified to produce a coating in any range from soft to hard, the greatest number of applications seem to be in the elastic, rubbery range. In this state, Unichrome Plastisols can outclass rubbers on toughness, chemical inertness and economy for many applications. And unlike ordinary protective coatings, Unichrome Plastisols absorb abuse and impact without chipping.

(3) Thick films can be produced. To guard against porosity in a coating and the possibility of accidental break-through, minimum film thicknesses are usually specified for protecting metals against strong corrosives. The thicker, the greater the protection. With ordinary coatings, this means applying many coats.

However, Unichrome Plastisol Compounds build up 3 mils to 3/16" thicknesses with a single prime and a single top coat. They "cure" to stable form at 350° in only 20 minutes.

TYPICAL RESULTS

Bleach reduction chambers of a noted chemical producer were coated with a Unichrome Plastisol Compound. This user reported that the coating gave 4 times longer service than even special alloy metals before requiring maintenance!

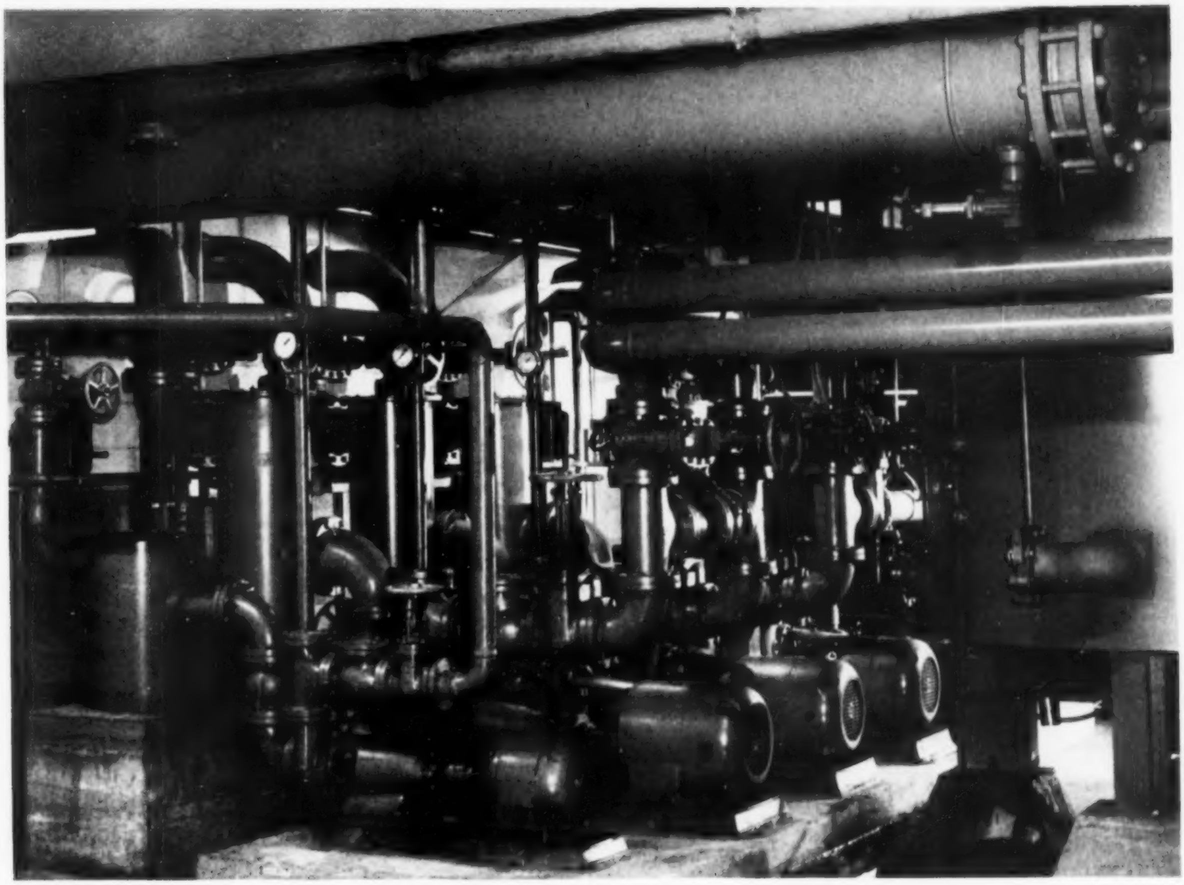
A processing plant replaced phenolic linings in equipment for spinning synthetic fibre with a Unichrome Plastisol Compound. By so doing, they ended build-up of hard sulfide deposits.

ENDLESS OTHER USES

When battling corrosive liquids and fumes, plastisol coatings are so thick and tough they can be depended on not to break or wear through. That's why they're used to coat drain boards, to line pipe and fittings, to protect ventilating fans, ducts, solution agitators, processing baskets and the like.

United Chromium's Technical Service department will be glad to give details on a specific plastisol to meet your problem. Write, giving details of the problem.

UNITED CHROMIUM, INCORPORATED
100 East 42nd St., New York 17, N. Y.
Detroit 20, Mich. • Waterbury 20, Conn.
Chicago 4, Ill. • Los Angeles 13, Calif.
In Canada:
United Chromium Limited, Toronto, Ont.



Controlled Quenching FOR BETTER PRODUCT

Battery of B & G Quench Tanks served by B & G Oil Cooling System illustrated above.

The above illustration typifies the quenching methods employed by modern metal fabricating plants to protect the quality of their products.

Here a battery of B & G *Hydro-Flo* Oil Coolers is employed to keep quench oil constantly at a predetermined temperature. By controlling quenching conditions, uniformity of product is assured.

B & G *Hydro-Flo* Self Contained Oil Coolers are complete packages... combining Coolers, Motors, Pumps, Strainers and all controls into single, integrated units. Fully automatic, they keep oil temperature at the desired degree through all stages of the quench.

Or if you prefer, the component parts of a B & G *Hydro-Flo* Oil Cooling System may be purchased and assembled on the job. B & G Quench Tanks are also available... either in standard designs or built to your specifications.

Send for Catalog and Simplified Selection Manual.

Hydro-Flo
OIL QUENCHING SYSTEMS

BELL & GOSSETT COMPANY
Dept. DA-16, Morton Grove, Ill.

*Reg. U. S. Pat. Off.

Canadian Licensee: S. A. Armstrong Ltd., 1400 O'Connor Drive, Toronto

The Experience

to solve *your* heat treating problems

YOUNG BROTHERS OVENS

Continuous-type stress relieving and paint baking oven

For over 50 years, Young Brothers has designed and built ovens for the leading firms in every field. The specialized knowledge and experience gained in thousands of successful oven installations is available to meet your particular needs. Young Brothers has a proud history of continually developing batch and conveyor ovens for new processes, materials and products.

Take advantage of the specialized engineering and construction skills that have solved both old and new heat-treating problems. Consult with Young Brothers first, for all your oven requirements.

Write for Bulletin 14-T.

YBCo Estab. 1896

YOUNG BROTHERS COMPANY

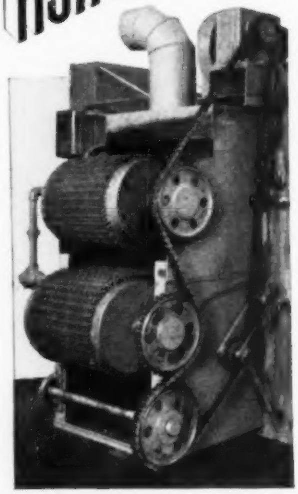
1829 Columbus Road Cleveland 13, Ohio

Metal Belts

for Processing and Handling all Materials . . .

engineered for the specific end use by

ASHWORTH



For applications ranging from subzero to 2100°F.

Our Engineering and Testing standards are your assurance of "The Right Belt" for the job.

WRITE FOR ILLUSTRATED CATALOG 52P

ASHWORTH BROS., INC.

METAL PRODUCTS DIV. • WORCESTER, MASS.

Sales Engineers: Buffalo • Chattanooga • Chicago • Cleveland • Detroit • Kansas City • Los Angeles • New York • Philadelphia • Pittsburgh • Rochester • Seattle • St. Paul • Tulsa — Canadian Rep., PECKOVER'S LTD. • Toronto • Montreal

Leitz MA IV b LABORATORY CAMERA with BMe METALLURGICAL MICROSCOPE

Versatility without costliness for photomicrography—photomacrography

A highly versatile, yet inexpensive combination. Indispensable for routine photomicrography or photomacrography, with Micro-Summar lenses. For plates and cut films 3¼ x 4¼ or 4 x 5 inches, black-and-white or color. Accessories available for varied requirements.

The camera—Direct vision reflex housing for grain counting. Vertical camera with bellows of 50 cm. Simplified time and instantaneous shutter. Rack and pinion for lens panel. Light-tight connecting sleeve for microscope.

The microscope—Built-in illumination. Large modern stand. Rack and pinion coarse focusing. Micrometer fine adjustment on double ball bearings. Interchangeable large square mechanical stage, adjustable vertically by rack and pinion. Dovetail slider for interchange of tubes. Large vertical illumination with compensating prism and plane glass.

Write to Dept. MP

E. LEITZ, INC., 468 FOURTH AVE., NEW YORK 16, N.Y.

DISTRIBUTOR OF WORLD-FAMOUS PRODUCTS OF ERNST LEITZ, WETZLAR, GERMANY

LEITZ MICROSCOPES • SCIENTIFIC INSTRUMENTS • BINOCULARS • LEICA CAMERAS AND ACCESSORIES

THERE'S HEAT THERE'S FAHRALLOY

WHERE THERE'S HEAT THERE'S FAHRALLOY WHERE THERE'S HEAT THERE'S FAHRALLOY

WHERE THERE'S HEAT THERE'S FAHRALLOY WHERE THERE'S HEAT THERE'S

FAHRALLOY...

has been solving heat and corrosion problems for over 20 years . . .

No Wonder

Fahralloy castings are used for the toughest of heat treating jobs . . .

Since 1933 the name Fahralloy has come to mean the answer to heat and corrosion problems of industry. And each answer has come about as a result of a thorough and individualized study of the particular problem. Fahralloy views the alloying of chrome, nickel and other metals as the pharmacist views the doctor's prescription. There's no place for guesswork. In fact, it's the metallurgically correct composition of Fahralloy castings that assures longer life under tough service conditions wherever high temperature is involved. Isn't it logical, then, to look to Fahralloy for the solution to your heat treating problems?

THE FAHRALLOY CO.

150th & Lexington Ave. — Harvey, Illinois

In Canada — Fahralloy Canada, Ltd., Orillia, Ontario

Just Published!

Send for Your Copy . . .

ALEXANDER SAUNDERS & CO.

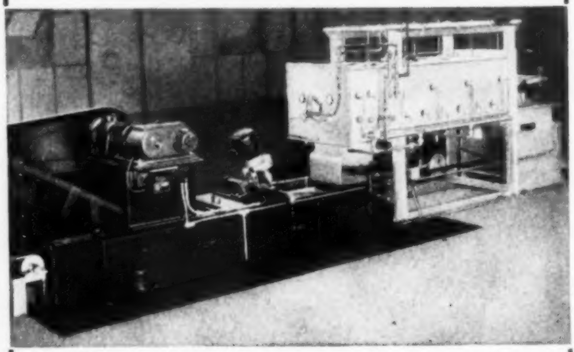
Precision Casting Equipment and Supplies

93 Bedford St. WAtkins 4-8880

New York 14, N. Y.

CONTINUOUS

HARDENING AND QUENCHING



By means of a smoothly operating reciprocating action the work constantly moves forward and feeds into the quench directly from the retort without air contact — A POSITIVE MEANS OF CLEAN HARDENING.

Ask AGF PIONEERS for Bulletins 815 and 820

AMERICAN GAS FURNACE CO.

1002 LAFAYETTE STREET, ELIZABETH 4, N. J.

Accurate Temperature Reading Cuts Costs — Reduces Waste!

USE THE NEW PYRO LOW COST Surface Pyrometer

Here's good news for plants and laboratories who've told us they wanted a low-cost, rugged instrument that will give accurate surface and sub-surface temperature readings under all operating conditions. The NEW PYRO Surface Pyrometer is quick-acting and fool-proof . . . no special experience needed to operate it. Big 4" dial. Catalog No. 180 gives full particulars.

THE NEW PYRO RADIATION PYROMETER

Tells spot temperature instantly — in heat-treating furnaces, kilns, forgings and fire boxes. No thermocouples, lead wires or accessories needed! Temperature is indicated on direct-reading dial at a press of the button. Any operator can use it. In two double-ranges for all plant and laboratory needs. Write for FREE Catalog No. 100.

Just sight it . . . and press the button!

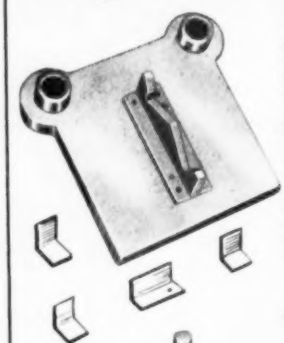
The Pyrometer Instrument Company

New Plant and Laboratory BERGENFIELD 8, NEW JERSEY

Manufacturers of Pyro Optical, Radiation, Immersion and Surface Pyrometers for over 25 years

Punches and Dies

Angle Iron Cut Off Die



No. 18, cut off die, for 2" x 2" x 1/4" and lighter angles. Mounted in leader pin die set. Fits 'most all makes of 25-ton and larger presses. Simple shearing action insures straight, clean cut WITHOUT DISTORTION. Another of the many different kinds of punches and dies in stock or made to order for foot, hand or power operation. Also adaptors and die shoes to convert your press. Each precision-made.

—or what have you?

What are your punch and die needs? Consult us about those problems. *Satisfaction is your reward when you Re-WARD your orders.*

Send for free illustrated catalog No. 152 AD. Net prices shown.

WARD Machinery Co. 564 West Washington **Chicago 6**

the 3rd. DIMENSION

May be the difference Between PROFIT and LOSS

Here's how *MicroRold*® Stainless Steel *Saves You Money*

The third dimension, or gauge thickness, is extremely important in the purchase and use of stainless steel. Job costs are figured on a square foot of stainless area basis while stainless sheets are purchased on a weight basis. Each one-thousandth inch saved in thickness saves 1.26 pounds per sheet.*

When sheets are ordered by gauge number, the permissible A.I.S.I. variation in thickness is plus or minus 10%. Thus, if you order 18 gauge you may receive sheets .052″ thick, when a thickness of .0475″ would suit your purpose. Using a standard 18 gauge 36″ x 120″ sheet as an example, the theoretical weight is 63.00 pounds, but this weight could permissibly vary between 59.22 pounds and 65.52 pounds.

MicroRold sheets may be ordered by gauge number and you may specify they be rolled on the light side of the gauge range. This is true because the company's equipment is such that more accurate control of thickness is possible.

If you are not a user of MicroRold sheet it will pay you to get the full details. Your steel warehouse distributor will gladly tell you the MicroRold story.

WASHINGTON STEEL CORPORATION
Washington, Pennsylvania

**36″ x 120″ standard size sheet.*

POWDER METALLURGY, LTD.

LONDON · ENGLAND

ARE able to supply you promptly

WITH custom-built alloy metal powders

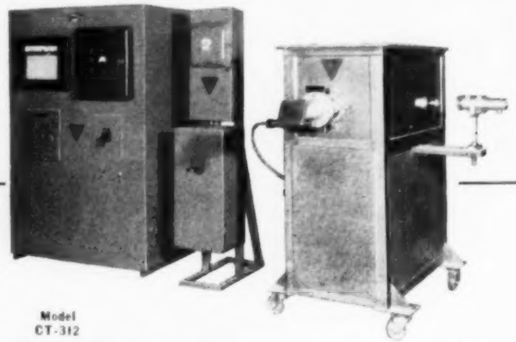
TO difficult or hard-to-get specifications.

IF in trouble of this sort

WRITE to . . .

POWDER METALLURGY LIMITED
59/62, HIGH HOLBORN
LONDON, W.C.1, ENGLAND

Precision Control At 5000°F.



PERECO

Carbon-Resistor Type TUBE FURNACE

Developed to meet the demands of both industry and military. Suited for investigations in the ultra-high (3500° - 5000° F.) temperature ranges in the field of either metallurgy or ceramics. Wide range of "turn-down" insures very accurate results. May also be duplicated repeatedly. Capable of holding to plus or minus 20° F. at 5000° F. Choice of extremely rapid or any slower cycle heat-up; close control of both temperature and power input; full-range, FAIL-SAFE, safety devices; and easy, low-cost element replacement.

Standard or Special Furnaces or Kilns from 450° F. to 5000° F.

Write for Bulletin

PERENY EQUIPMENT CO.

Dept. Q, 893 Chambers Rd., Columbus 12, O.

PERENY EQUIPMENT COLUMBUS OHIO

KING PORTABLE BRINELL

HARDNESS TESTER

Eliminates excessive material handling costs in routine and special Brinell hardness testing. The King Portable Brinell can be carried to the work, used in any position, and always puts an actual load of 3000 kg. on the 10-mm. ball indenter.

This 27-lb. portable tester has a 4-in. deep throat and a gap 10 in. high. For larger pieces, the test head is easily removable for testing sections beyond the capacity of the standard base.

Throat—4" deep. Gap—10" high. Weight—27 lbs.

Simple to operate, the tester is impossible to overload, and even with inexperienced operators will provide consistent accurate results well within the requirements of the Bureau of Standards.

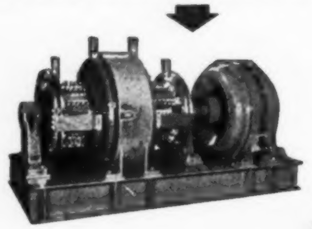
ANDREW KING
BOX 606 A
ARDMORE, PENNA.

COLUMBIA

MOTOR GENERATORS

for

Electroplating
Anodizing
Electrocleaning
Electropolishing



TONG TEST AMMETERS

- REVERSING SWITCHES
- TANK RHEOSTATS

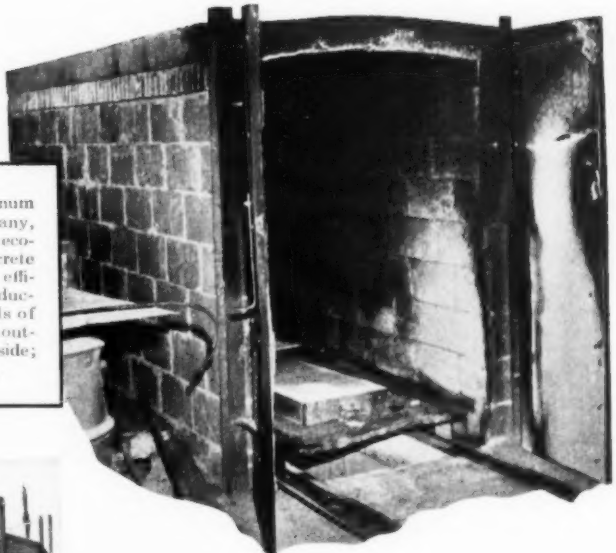
Write for Descriptive Bulletins

COLUMBIA ELECTRIC MFG. CO.
4531 Hamilton Ave. • Cleveland 14, Ohio

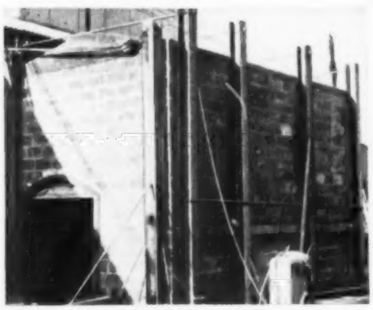
What's NEW in Refractories?

REFRACTORY CONCRETE BLOCKS

Speed Construction...Cut Costs



PRE-HEATING FURNACE for aluminum scrap at General Smelting Company, Philadelphia, Pa., was quickly and economically built with refractory concrete block. It was designed for peak efficiency at an estimated 30% cost reduction over conventional methods of construction. Furnace is 16′ long outside, 3′9″ wide and 5′9″ high inside; generates temperatures to 1500°F.



UNDER CONSTRUCTION—General Smelting Company was so pleased with the performance of the pre-heating furnace they specified refractory concrete blocks again for this new calcining kiln settling chamber. Roofs of both installations are monolithic sections of refractory concrete.

Here's a new idea in refractories that promises new economies in many industrial plants. Concrete block made with *refractory* concrete chalked up a big 30% saving in construction costs on a pre-heating kiln at General Smelting Company, Philadelphia, Pa.

The large blocks were quickly placed by plant labor. No form work was needed. And they furnish both heat resistance and structural strength.

Whether in block form, or placed on the job, *refractory concrete* assures long-service life. With Lumnite* calcium-aluminate cement and suitable aggregates, it can be made to take high temperatures—often up to 2600°F. Low volume change makes it highly resistant to thermal shock, and it also resists corrosion.

FOR CONVENIENCE, you may prefer to place refractory concrete made with prepared castables (packaged mixes of Lumnite Cement and aggregates selected for specific temperatures and insulation service—add only water). They are made by refractory manufacturers and sold through their dealers. For more information, write Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.

M-L-82

ATLAS® LUMNITE for INDUSTRIAL CONCRETES

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

Metal Progress

Taylor Lyman, *Publisher*

A. P. Ford, *Sales Manager*

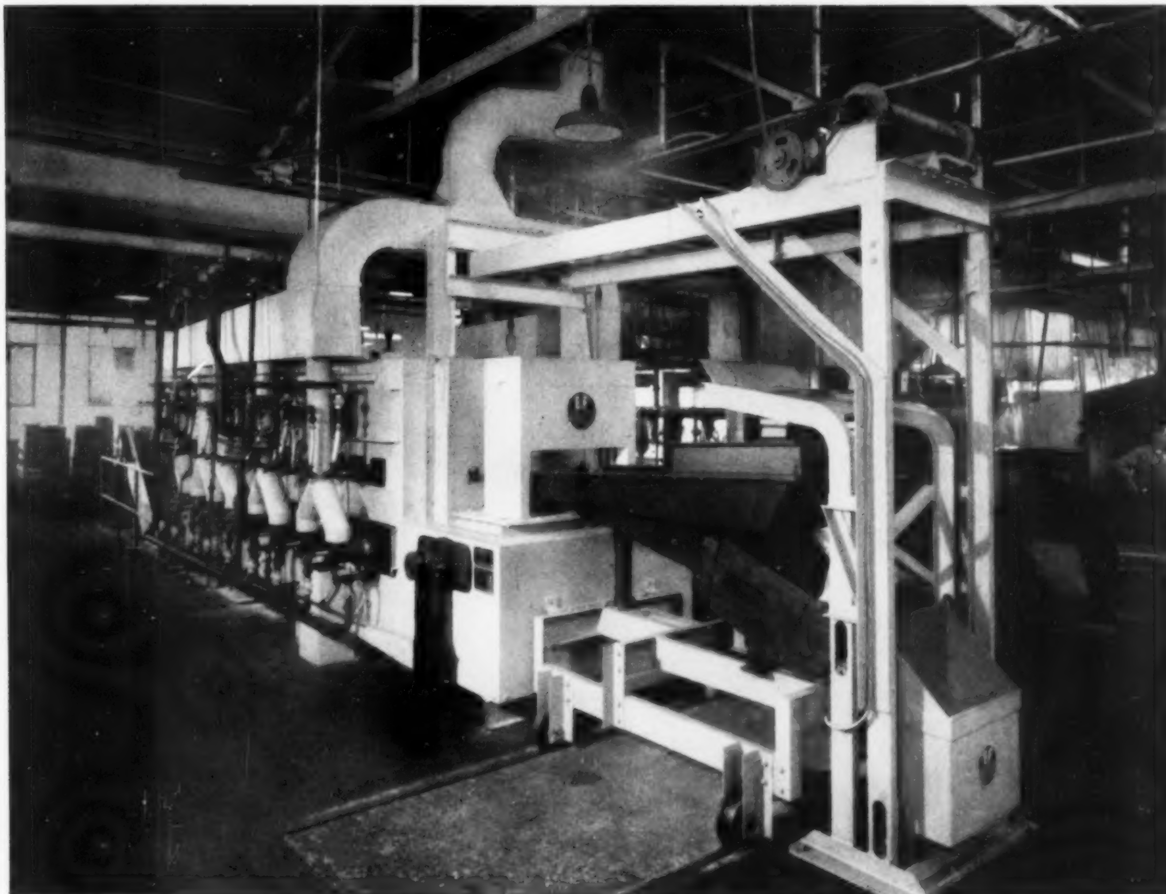
George H. Loughner, *Production Manager*
7301 Euclid Ave., Cleveland 3—UTah 1-0200

District Managers
John F. Tyrrell and John B. Verrier, Jr.
55 W. 42nd St., New York 18—CHickering 4-2713
Ralph H. Cronwell
482 Burton Ave., Highland Park, Ill.—HIghland Park 2-4263
Don J. Billings
7301 Euclid Ave., Cleveland 3—UTah 1-0200

PUBLISHED BY AMERICAN SOCIETY FOR METALS, 7301 EUCLID AVE., CLEVELAND 3, OHIO—W. H. EISENMAN, SECRETARY

• Index to Advertisers •

TOWER PRESS
CLEVELAND



For Hardening Small Parts

Uniformly — Scale-free — Continuously

175 to 2000 lbs. per hour

● The EF chain belt conveyor furnace is one of the most satisfactory continuous heating units yet devised for scale-free hardening, carbon restoration and non-decarb heat treating small and medium size parts. The material is loaded onto a rugged heat resisting cast link conveyor belt; carried through the furnace; heated uniformly to proper temperature; automatically quenched and discharged. No pans or trays are needed. Hundreds in daily operation prove the dependability and efficiency of our design. 11 standard sizes. Capacities to 2000 lbs. or more per hour. Gas, oil or electrically heated. Furnished complete with any desired feeding or discharging equipment. Write for folders describing our chain belt and other production furnaces.

Ask For Bulletin 461-CB.

EF
GAS-FIRED
OIL-FIRED
and ELECTRIC
FURNACES
for

- AGING
- ANNEALING
- BRAZING
- ➡ CARBON RESTORATION
- CARBURIZING
- CERAMIC DECORATING
- DRAWING
- ➡ HARDENING
- HOMOGENIZING
- MALLEABLIZING
- NORMALIZING
- NITRIDING
- SINTERING
- SOLUTION TREATING
- ➡ SPECIAL ATMOSPHERE TREATMENTS

EF

THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES
FOR ANY PROCESS, PRODUCT OR PRODUCTION

WILSON STREET *Salem - Ohio*

Canadian Associates ● CANEFCO LIMITED ● Toronto 1, Canada

117 Liberty Street, New York, New York
1578 Union Commerce Bldg., Cleveland, Ohio
528 Fisher Building, Detroit, Michigan
176 W. Adams Street, Chicago, Illinois
7251 General Motors Bldg., Detroit, Michigan
3104 Smith Tower, Seattle, Washington
P. O. Box 1633, Tulsa, Oklahoma
325 W. 17th Street, Los Angeles 15, Calif.
Monadnock Building, San Francisco 5, Calif.
1140 Lockwood Drive, Houston 20, Texas
803 Loew Building, Syracuse, New York